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TRANSACTIONS.

ABSTRACTS

(Papers of which the title only is cited are marked with an *.)

Über Zuckerbestimmung mittels des „Verdünnungsverfahrens."[1]

Von Riichiro KÔKETSU.

(Eingegangen am 25. Februar 1924.)

Zur quantitativen Zuckerbestimmung gibt es bereits verschiedene brauchbare Methoden, wenn auch eine exakte Bestimmungsmethode bisher noch nicht gefunden ist. Von Zeit zu Zeit findet sich daher in der Literatur Mitteilung von neuen Verfahren und Modifikationen (1. 4). Da, wo nun exakte, quantitative Daten nicht erforderlich sind, sondern eine relative Bestimmung schon genügt, ist die übliche titrimetrische oder gravimetrische Bestimmung überflüssig, ganz besonders deshalb, weil diese Bestimmungsmethoden für unerfahrene Hände sehr schwer fehlerlos durchzuführen sind und überdies die Durchführung dieser Verfahren dort, wo es sich um sehr geringe Mengenverhältnisse handelt, sehr schwierig, wenn nicht gar unmöglich ist. Es mag deshalb von Wert sein, eine Methode zu besitzen, die leicht und auch mit geringem Analysenmaterial durchführbar ist, und das ganz besonders in der Pflanzenphysiologie, wo relative Daten über den Zuckergehalt häufig gewünscht werden.

Da scheint mir ein Verfahren, bei dem man eine reagierbare Grenzkonzentration des Reagens zu finden sucht, so wie es bei der serodiagnostischen Bestimmung der Verwandtschaft von Eiweisstoffen durch die Präcipitinreaktion gewöhnlich benützt wird, oder wie bei der Bestimmung des Verdünnungsgrades einer Eiweisslösung, wo die Präcipitinreaktion zuerst sichtbar wird, auch bei der Zuckerbestimmung verwendbar zu sein (2. 5). Es handelt sich darum denjenigen Verdünnungsgrad einer Zuckerlösung zu bestimmen, in dem eine bestimmte Menge der Lösung mit einer bestimmten Menge Fehlingscher Lösung eine zuerst sichtbare Reaktion gibt. Es wird also der Zuckergehalt einer Lösung oder eines Extraktes, nachdem er einige Minuten lang im Wasserbade gekocht wird, durch Beobachtung der Grenzkonzentration des ersten Niederschlages von Kupferoxydulkörnchen oder der ersten vollständigen Entfärbung der Lösung bestimmt. Die Verdünnungen der zu untersuchenden Zuckerlösung werden in dem bei dem Präcipitinsverfahren üblichen Verhältnisse mit destilliertem Wasser hergestellt und wie folgt numeriert (5):

Verdünnungsnummer:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Verdünnungsgrad:	1	2	4	8	16	32	64	128	256	512 fach.

(1) Arbeiten aus dem botanischen Laboratorium der Kaiserlichen Kyushu-Universität, Nr. 1.

Danach ist also der Verdünnungsgrad des Zuckergehaltes einer Lösung doppelt so klein wie in der nächsten.

Die für diesen Zweck erforderliche Fehlingsche Lösung wird nach den Vorschriften von Fehling-Soxhlet (3) hergestellt. Da aber bei diesem Gemisch häufig, auch wenn es frisch hergestellt wurde, eine Ausscheidung von Kupferoxydulkörnchen ohne Zusatz von Zucker selbstständig stattfinden kann, und zwar um so leichter, wenn das Gemisch gekocht wird, so verringert man, um diese Fehlerquelle auszuschalten, den Kupfervitriolgehalt der Lösung. Bei dieser notwendigen Modifikation der Fehlingschen Lösung wird die Mischungsrate der Fehling-Soxhletschen Lösung I (Kupfervitriol) und II (Seignettesalz) in dem Verhältnis von 1 : 2 anstatt 1 : 1 hergestellt.

Nun wird je eins der eine Serie bildenden Gläschen mit je 1 ccm der verschiedenen verdünnten Lösungen beschickt und numeriert. Dann wird allen Gläschen je 1 ccm Fehlingscher Lösung zugesetzt. Es enthält also nun jedes der Gläschen 2 ccm des Gemisches. Ein Kontrollgläschen enthält 1 ccm Fehlingscher Lösung und 1 ccm destillierten Wassers anstatt der Zuckerlösung. Nachdem der Inhalt jedes einzelnen Gläschens durch Schüttern gut gemischt wurde, werden alle Gläschen in das Wasserbad gebracht, darin 5 Minuten lang gekocht und dann auf einem Tische eine Weile lang stehen gelassen. Jetzt sieht man nach, in welchem der numerierten Gläschen ein sichtbarer Niederschlag von Kupferoxydul oder eine vollständige Entfärbung des Gemisches zuerst stattfindet. Die betreffende Grenze aber ist besser zu bestimmen, wenn man die Gläschen zentrifugiert, um die Kupferoxydulkörnchen von der Lösung schnell und vollständig zu trennen. Wenn man ferner bei diesem Verfahren anstelle der obenerwähnten Fehlingschen Lösung z. B. eine 8fach verdünnte benützt, so tritt die Niederschlagsgrenze meist schärfer hervor, es ist dann die Entfärbungsgrenze allerdings schwieriger zu bestimmen. Zunächst gebe ich hier tabellarisch ein Beispiel eines mit diesem Verfahren erhaltenen Resultates:

Als Stammlösung benutzte Zuckerlösung	Benutzte Fehlings-Lösung	Nummer der vollständ. Entfärb.	Verdünnung, bei der zuerst eintritt: Sichtbarer Niederschlag: Vor d. Zentrif.	Nach d. Zentrif.
1% Traubenzucker	unverdünnt	2	7	9 – 10
0.1% „	„	–	4	6
Triticum-Samenextrakt(1)	„	–	5	7
1% Traubenzucker	8fach verd.	4 – 5	7	9
0.1% „	„	1 – 2	4	6
Triticum-Samenextrakt	„	3	5	7

(1) 5 g Samen wurden fein zermahlen und einfach mit 50 ccm Wasser extrahiert.
– bedeutet, dass die vollständige Entfärbung im ersten Gläschen noch nicht stattfindet.

Aus dieser Tabelle geht hervor, dass der Gehalt an reduzierendem Zucker im *Triticum*-Extrakt etwa doppelt so gross ist, als der einer 0.1%igen Traubenzuckerlösung oder 8mal so klein als der einer 1%igen Zuckerlösung, weil der Zuckergehalt in dem einen Gläschen ja zweimal so gross ist wie der des nächsten Gläschens. Mit anderen Worten: es lässt sich betreffende Zuckergehalt auf ca. 0.2–0.125% schätzen.

Die nennenswerten Vorteile dieses Verfahrens, welches wir das „Verdünnungsverfahren" nennen wollen, bestehen darin, dass es erstens mit einer relativ geringen Menge Materials ausführbar ist, und dass zweitens wir in ein und demselben Verfahren drei Punkte und zwar die Entfärbungsgrenze und die Niederschlagsgrenze vor und nach dem Zentrifugieren nebeneinander als Indizien zur Zuckerbestimmung beobachten können. Es werden also Beobachtungsfehler, die bei Beobachtung nur einer Grenze eingetreten sein können, vermieden. Selbstverständlich ist aber auch diese Methode der Zuckerbestimmung nicht ganz von Fehlerquellen frei, besonders sind dann Fehler möglich, wenn man einen unreinen Zuckerextrakt als Stammlösung benützt. Die vorangehende Reinigung der Stammlösung ist also, wie bei meisten anderen, so auch bei unserem Verfahren wenigstens wünschenswert, wenn sie auch vielleicht manchmal, je nach den Umständen, nicht nötig sein mag.

In folgendem will ich als weiteres Beispiel die Veränderung des Gehaltes an reduzierenden Zuckerarten in *Triticum*-Arten während des Keimprozesses, so wie ich sie mittels des Verdünnungsverfahrens verfolgte, darstellen. Es wurden 4 Gruppen von je 5 g lufttrockenen Samen hergestellt und drei davon im Keimapparat ausgesät und immer nach 2 Tagen der Zuckergehalt einer Gruppe bestimmt. Die Herstellung der Stammlösung geschah jedesmal so, dass die betreffende Gruppe Samen fein zermahlen, mit 50 ccm destilliertem Wasser extrahiert und dann filtriert wurde. Die Verdünnung und Numerierung der Lösungen waren dieselben wie bei dem vorhergehenden Beispiel. Die Ergebnisse waren:

I. Mit *unverdünnter* Fehlingscher Lösung.

Material.	Nummer der vollständigen Entfärbung.	Verdünnung, bei welcher zuerst stattfindet: Sichtbarer Niederschlag: Vor d. Zentrif.	Nach d. Zentrif.	Bemerkungen. Frisch-gewicht.	Keimungs-grad.
1. Ungesät	–	4	6	5.00 g	–
2. 2 Tage nach Aussaat	1	6	8	6.84	Sehr schwach
3. 4 Tage nach Aussaat	1 – 2	6 – 7	8 – 9	7.84	Keimlinge ziemlich gross
4. 6 Tage nach Aussaat	3	7	9	9.98	Keimlinge noch grösser

II. Mit *8fach-verdünnter* Fehlingscher Lösung.

1.	2 - 3	4 - 5	6
2.	4	6	8
3.	5	7	8
4.	6	7 - 8	9

Aus dieser Tabelle geht hervor, dass der Zuckergehalt der keimenden *Triticum*-Samen zuerst schnell und dann allmählich zunimmt, was theoretisch auch zu erwarten ist (6).

Es scheint mir dieses Verfahren mindestens zu Demonstrationszwecken auf dem Gebiete der Pflanzenphysiologie gut verwendbar zu sein.

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Fungi Collected in the Islands of Rishiri and Rebun, Hokkaido.

By Kôgo TOGASHI.

[With Plate V.]

(Communication from the Phytopathological Laboratory, Hokkaido Imperial University. Received March 10, 1924.)

Introduction.

Rishiri-Island lies about 28 kilometers off the west coast of Prov. Kitami on the north-west of the main-island of Hokkaido. It extends from 45°5′ to 45° 14′ N. Lat. and from 141° 8′ to 141° 20′ E. Long. and covers an area of 185 square kilometers. Rebun-Island is situated in the intersects of 45° 16′ and 45° 28′ N. Lat. and in the meridian of 140° 57′ and 141° 4′ E. Long., lying about 16 kilometers from Rishiri-Island to the north-west and has an area of 77 square kilometers. In spite of their small areas, many botanists have taken a special interest in the flora of these islands because it is very rich in species, some of which being very rare in Japan.

In 1899, the late Mr. Takiya KAWAKAMI (28) had spent 40 days in Rishiri-Island for the purpose of botanical collection and published the results of the study in the next year. In that report, he says "The fungi collected in the island are more than 50 species and some of them are very rare. The following fungi are obtained at the grass-region at the altitude of 4000 feet or more:—*Cladochytrium Krugerianum* (MAGN.) FISCH.? on the leaves and stems of *Conioselium univittatum* TURCZ.; *Uromyces acutatum* FCKL. (=*U. japonicus* BERK. et CURT.)[1] on the leaves of *Allium Victorialis* L.; *U. Solidaginis* (SOMMF.) NIESSL. on the leaves of *Solidago Virga-aurea* L.; *Puccinia Schelliana* THÜM. (=*P. vesculosa* SCHLECHT.) on the leaves of *Anemone narcissiflora* L. var. *sachalinensis* MIYABE et MIYAKE; *P. mamillata* SCHRÖT. (=*P. calumnata* SYD.) on the leaves of *Polygonum Weyrichii* FR. SCHM.; *Ustilago vinosa* (BERK.) TUL. on the ovary of *Oxyria digyna* HILL. Besides those above mentioned, *Aecidium* sp. (=the æcidial stage of *Puccinia Festucae* PLOWR.) on *Lonicera coerulea* L.

(1) The names in parentheses are added by the writer, which are now considered to be the correct names by the later studies.

var. *villosa* TORR. et GRAY; *Puccinia* sp. on *Sedum Rhodiola* DC. var. *Tachiroi* FR. et SAV. and *Ustilago* sp. on *Polygonum Bistorta* L. var. *vulgare* MEISN. were collected."

In the summer of 1907, Mr. Michiya MIURA visited Rishiri- and Rebun-Islands and collected many specimens of fungi. Through his kindness, I have had the opportunity of examining the specimens, a part of which had already been announced by H. and P. SYDOW (58) in 1913.

My own visit was paid in the summer of 1922, together with the late Mr. Takeo GOTO, an assistant of our botanical institute and Mr. Naohide HIRATSUKA, a student of our college. Our party had first landed at Oniwaki in Rishiri-Island and from thence we ascended Mt. Rishiri, 1698 m. in height. Then I made the further exploration of Rishiri- and Rebun-Islands with Mr. N. HIRATSUKA. The second visit was attempted in the autumn of 1923. In the course of my two explorations I obtained more than 130 species of fungi. Among them 10 species are considered as the new additions to the mycological flora of Japan and the following 8 species are ascertained to be new to science:—*Puccinia Ligulariae* MIYABE et MIYAKE; *P. Nepetae* TOGASHI; *Plaeospora Hiratsukae* TOGASHI; *Septoria Artemisiae-japonicae* TOGASHI; *S. Haleniae* TOGASHI; *Stagonospora Pini-pumilae* TOGASHI; *Cercospora Gotoana* TOGASHI; *C. Polygonati-Maximowiczii* TOGASHI.

All specimens are deposited in the herbarium of the College of Agriculture, the Hokkaido Imperial University.

The writer takes pleasure in acknowledging his indebtness and in extending his sincere thanks to Profs. K. MIYABE and S. ITO for their kind criticism and valuable advice, to Assistant Prof. Y. TOCHINAI for his constant encouragement and also to Dr. S. HORI, Lecturer S. KAMEI, and Miss. Y. HOMMA for their kind assistance in the identifications of *Cercospora*, *Uredinopsis*, Erysiphaceae, respectively. Finally the writer owes a deep debt of gratitude to Dr. Y. KUDO and Mr. M. TATEWAKI for the identification of the host plants.

PHYCOMYCETES.

Albuginaceae.

1. Albugo candida (PERS.) KUNTZE.

Hab. On the leaves of *Brassica chinensis* L. (Aburana), (cultivated). Rishiri-Island:—Ishizaki, Aug. 7, 1922, K. TOGASHI.

Peronosporaceae.

2. Bremia Lactucae Regel.

Hab. On the leaves of *Lactuca Raddeana* Max. (Yama-nigana). Rebun-Island :—Kabuka, Aug. 8, 1922, K. Togashi.

On the leaves of *Picris japonica* Thunb. (Kozorina). Rishiri-Island :—Ishizaki, Aug. 7, 1922, K. Togashi. Rebun-Island :—Aug. 24, 1907, M. Miura ; Kabuka, Aug. 9, 1922, K. Togashi.

Remarks. The present fungus is very common and very widely distributed. In 1919, J. Schweizer (54) reported that it is parasitic on 24 genera and 124 species of Compositae. Before that time in 1914, K. Sawada (50) differentiated following five new species of *Bremia* from *B. Lactucae* based on the difference in morphological characters as well as in the results of inoculation experiments ; *B. microspora* on *Lactuca debilis*, *B. elliptica* on *Lactuca brevirostris* and *L. formosana*, *B. ovata* on *Crepis japonica*, *B. Saussureae* on *Saussurea affinis* and *B. Sonchi* on *Sonchus oleraceus*.

In 1923, H. Sydow (59) described two species of *Bremia* on *Senecio* and *Centaurea* based upon Schweizer's studies on *B. Lactucae* and named them *B. Senecionis* and *B. Centaureae* respectively.

The conidia of the forms on *Lactuca Raddeana* and *Picris japonica* which were collected in Rishiri- and Rebun- Islands are respectively elliptical-shaped in fresh materials and measure $20 - 26 \times 18 - 24\ \mu$, and $16 - 22 \times 15 - 20\ \mu$ respectively. According to J. Schweizer's (54) morphological subdivision, these two forms belong to "Ein grosssporiger Typus mit länglich- bis flach-elliptischen Konidien." And he also proved that *Bremia Lactucae* on one genus of Compositae did not infect the members of other genera. Until further study is prosecuted, we shall retain our two forms under the name of *Bremia Lactucae*.

3. Phytophthora infestans (Mont.) De Bary.

Hab. On the leaves of *Solanum tuberosum* L. (Jaga-imo), (cultivated). Rebun-Island :—Aug. 24, 1907, M. Miura ; Funadomari, Aug. 10, 1922, K. Togashi.

4. Peronospora alta Fuck.

Hab. On the leaves of *Plantago major* L. var. *asiatica* Decne. (Obako). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 9, 1922, K. Togashi.

5. Peronospora Chenopodii Casp.

Hab. On the leaves of *Chenopodium album* L. (Akaza). Rishiri-Island :—Aug. 15, 1907, M. Miura ; Oniwaki, Aug. 4, 1922, K. Togashi. Rebun-Island :—Niotomari, Aug. 10, 1922, K. Togashi.

6. Peronospora leptosperma De Bary.

Hab. On the leaves of *Artemisia vulgaris* L. var. *yezoana* Kudo (Yezo-yomogi). Rishiri-Island :—Oniwaki, Aug. 4, 1922 ; Oshidomari, Aug. 7, 1922, K. Togashi. Rebun-Island :—Niotomari, Aug. 10, 1922, K. Togashi.

7. Plasmopara nivea (Ung.) Schroet.

Hab. On the leaves of *Cryptotaenia japonica* Hasskari. (Mitsuba-zeri). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

On the leaves of *Angelica refracta* Fr. Schm. (Yezo-Obasenkiu). Rishiri-Island :—Oshidomari, Oct. 10, 1923, K. Togashi.

On the leaves of *Ligusticum scoticum* L. (Maruba-toki). Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

Remarks. *Ligusticum scoticum* seems to be a new host plant to the present fungus. So far as can be ascertained by the writer, there is no record that this fungus affects any species of *Ligusticum* except *L. Mutellina* reported by A. Wartenweiler (67). The morphological characters of the *Plasmopara* on *L. scoticum* collected in Rebun-Island correspond exactly to *P. nivea*. The general character of the *Plasmopara* on *Ligusticum scoticum* is as follows :—

Conidiophores erect, 3–5–fasciculate from the stomata, two or three times monopodially branched at right angles to the main axis, ultimate branches 2–3, widely divergent, $148-208 \times 7-10$ μ ; conidia broad ellipsoidal or ovoid, slightly papillate, hyaline or subhyaline, $24-37 \times 18-20$ μ.

ASCOMYCETES.

Erysiphaceae.

8. Erysiphe Cichoracearum DC.

Hab. On the leaves of *Artemisia vulgaris* L. var. *yezoana* Kudo. (Yezo-yomogi).

Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi.

On the leaves of *Plantago kamtschatica* Link. (Yezo-obako).

Rishiri-Island :—Oshidomari, Oct. 8, 1923, K. Togashi.

On the leaves of *Plantago major* L. var. *asiatica* Decne. (Obako). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

9. Erysiphe Galeopsidis DC.

Hab. On the leaves of *Galeopsis Tetrahit* L. (Chishima-odoriko). Rishiri-Island :—Ishizaki, Aug. 7, 1922, K. Togashi. Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

10. Erysiphe Polygoni DC.

Hab. On the leaves of *Geranium erianthum* DC. (Chishima-furo). Rebun-Island :—Momoiwa, Oct. 12, 1923, K. Togashi.

On the peduncles, petioles and leaves of *Geranium sibiricum* L. (Ichige-furo). Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

On the leaves of *Picris japonica* Thunb. (Kozorina). Rishiri-Island :—Otatomari, Aug. 7, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 9, 1922, K. Togashi.

On the leaves of *Thalictrum minus* L. var. *elatum* Lecoy. (Aki-karamatsu). Rebun-Island :—Funadomari, Aug. 11, 1922, K. Togashi.

11. Phyllactinia corylea (Pers.) Karst.

Hab. On the leaves of *Morus bombycis* Koidzumi. (Kuwa). Rishiri-Island :—Oshidomari, Oct. 10, 1923, K. Togashi.

12. Sphaerotheca fuliginea (Schlecht.) Sawada.

Hab. On the leaves and petioles of *Impatiens Noli-tangere* L. (Kitsurifune). Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

13. Uncinula Salicis (DC.) Wint.

Hab. On the leaves of *Betula Maximowicziana* Rgl. (Udai-kamba). Rishiri-Island :—Oniwaki, Oct. 11, 1923, K. Togashi.

14. Rhytisma acerinum (Pers.) Fr.

Hab. On the leaves of *Acer pictum* Thunb. var. *Mono* Pax. (Itaya-kaede). Rishiri-Island :—Oshidomari, Oct. 10, 1923, K. Togashi. Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

15. Rhytisma salicinum (Pers.) Fr.

Hab. On the leaves of *Salix sachalinensis* Fr. Schm. (Nagaba-yanagi). Rishiri-Island :—Oniwaki, Oct. 11, 1923, K. Togashi.

Mollisiaceae.

16. Beloniella Skimmiae Miyabe et Togashi.

Hab. On the leaves of *Skimmia japonica* Thunb. (Miyama-shikimi).
Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

17. Pseudopeziza Peracarpae Miyabe et Togashi.

Hab. On the leaves of *Peracarpa circaeoides* Fee. (Tani-gikyo).
Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

Hypocreaceae.

18. Balansia vorax (Berk. et Durt.) Atkinson ?

Hab. On the inflorescences of *Carex sachalinensis* Kuek. (O-itosuge).
Rebun-Island :—Momoiwa, Aug. 9, 1922, K. Togashi.

Remarks. This specimen is immature, so I could not identify it certainly.

19. Claviceps microcephala (Wallr.) Tul.

Hab. On the inflorescences of *Calamagrostis Epigejos* Roth. var. *densiflora* Ledeb. (Hoso-yamaawa). Rishiri-Island :—Sempoji, Oct. 8 1923, K. Togashi.

Dothideaceae.

20. Coccodiella Arundinariae Hara.

Hab. On the leaves of *Sasa kurilensis* Mak. et. Shib. (Chishima-zasa).
Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

Remarks. *Sasa kurilensis* is a new addition to the list of the host plants of the fungus.

Phyllachoraceae.

12. Phyllachora graminis (Pers.) Fuck.

Hab. On the leaves of *Brachypodium japonicum* Miq. (Yama-kamojigusa).
Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi.

On the leaves of *Elymus dahuricus* Turcz. (Hama-mugi).
Rishiri-Island :—Oshidomari, Oct. 10, 1923, K. Togashi.

On the leaves of *Elymus mollis* Trin. (Tenkigusa).
Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi.

22. Phyllachora Poae (Fuck.) Sacc. ?

Hab. On the leaves of *Poa acroleuca* Steud. (Mizo-ichigotsunagi).
Rishiri-Island :—Mt. Rishiri, Aug. 5, 1922, K. Togashi.

Remarks. This specimens immature.

23. Phyllachora Shiraiana Syd.

Hab. On the leaves of *Sasa kurilensis* Mak. et Ship. (Chishima-zasa). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 5, 1922, K. Togashi.

Remarks. *Sasa kurilensis* is a new addition to the list of the host plants of the present fungus.

Valsaceae.

24. Valsa ambiens (Pers.) Fr.

Hab. On the branches of *Salix sachalinensis* Fr. Schm. (Nagaba-yanagi, Karafuto-yanagi). Rishiri-Island :—Oniwaki, Aug. 7, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 9, 1922, K. Togashi.

BASIDIOMYCETES.

Ustilaginaceae.

25. Sphacelotheca Hydropiperis (Schm.) De Bary.

Hab. On the inflorescences of *Polygonum Blumei* Meisn. (Inu-tade). Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi. Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

26. Ustilago utriculosa (Nees.) Unger.

Hab. On the inflorescences of *Polygonum nodosum* Pers. (O-inutade). Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi.

27. Ustilago vinosa (Berk.) Tul.

Hab. On the inflorescence of *Oxyria digyna* Hill. (Maruba-gishigishi). Rishiri-Island :—Mt. Rishiri, Aug. T. Kawakami.

Melampsoraceae.

28. Chrysomyxa expansa Diet.

Hab. On the leaves of *Rhododendron chrysanthum* Pall. (Kibana-shakunage). Rishiri-Island ;—Mt. Rishiri, III, Aug. 5, 1922, K. Togashi.

Remarks. In 1915, Prof. K. Miyabe (36) proved the genetic relation between *Chrysomyxa expansa* and *Peridermium Piceae-hondoensis* by infection experiments and *Rhododendron chrysanthum* is also included by him among the

host plants of the fungus. As far as the writer is aware, no account concerning the occurrence of *Chrysomyxa Rhododendri* on *Rhododendron chrysanthum*, except a short note by A. A. Elenkin (9) in 1914 has been published. It may safely be assumed that the fungus in question is *Ch. expansa*, even though my specimens are somewhat incomplete.

29. Chrysomyxa Rhododendri De Bary.

Hab. On the leaves of *Picea Glehni* Mast. (Aka-yezomatsu).
Rishiri-Island :—Otatomari, I, Aug. 7, 1922, K. Togashi.

30. Cronartium ribicola Fisch.

Hab. On the leaves of *Ribes sachalinensis* Nakai. (Toga-suguri).
Rebun-Island :—Uinnai, II, III, Aug. 10, 1922, K. Togashi.

31. Melampsora Kusanci Diet.

Hab. On the leaves of *Hypericum crassifolium* Nakai. (Mizu-otogiri).
Rishiri-Island :—Otatomari, II, Aug. 7, 1922 ; III, Oct. 8, 1923, K. Togashi.

32. Melampsora Larici-opaca Miyabe et Matsumoto

Hab. On the leaves of *Salix sachalinensis* Fr. Schm. (Nagaba-yanagi).
Rishiri-Island :—Oniwaki, II, Aug. 4, 1922, K. Togashi.

33. Melampsora Larici-populina Kleb.

Hab. On the leaves of *Populus nigra* L. var. *italica* Duroi. (Itariya-yamanarashi) (cultivated).
Rishiri-Island :—Sempoji, II, III, Oct. 8, 1923, K. Togashi.

34. Melampsorella Caryophyllacearum Schroet.

Hab. On the leaves of *Stellaria yezoensis* Max. (Yezo-fusuma).
Rishiri-Island :—Mt. Rishiri, II, Aug. 5, 1922, K. Togashi. Rebun-Island :—Uinnai, II, Aug. 10, 1922, K. Togashi.

On the leaves of *Cerastium triviale* Link. var. *glandulosum* Koch. (Miminagusa). Rishiri-Island :—Sempoji, II, Oct. 8, 1923, K. Togashi.

35. Melampsoridium Alni (Thuem.) Diet.

Hab. On the leaves of *Alnus Maximowiczii* Callier. (Udai-kamba).
Rishiri-Island :—Oshidomari, II, III, Oct. 10, 1923, K. Togashi. Rebun-Island :—Kabuka, II, III, Oct. 12, 1923, K. Togashi.

36. Mescpsora Hypericorum (DC.) Diet.

Hab. On the leaves of *Hypericum erectum* Thunb. f. *Fauriei* (Keller) Miyabe et Miyake. (Otogiriso). Rishiri-Island :—Mt. Rishiri, II, III, July 21, 1899, T. Kawakami ; II, III, Aug. 5, 1922, K. Togashi. Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. Togashi.

On the leaves of *Hypericum yezoense* Max. (Yezo-otogiri). Rishiri-Island :—II, III, Aug. 21, 1899, T. Kawakami. Rebun-Island :—Momoiwa, II, Aug. 9, 1922, K. Togashi.

37. Pucciniastrum Agrimoniae (Diet.) Tranz.

Hab. On the leaves of *Agrimonia pilosa* Ledeb. (Kin-mizuhiki). Rishiri-Island :—II, III, Aug. 25, 1894, K. Miyabe ; Oshidomari, II, Aug. 3, 1899, T. Kawakami ; Mt. Rishiri, II, Aug. 5, 1922, K. Togashi.

38. Pucciniastrum Epilobii (Pers.) Otth.

Hab. On the leaves of *Epilobium angustifolium* L. (Yanagi-ran). Rishiri-Island :—Oshidomari, III, Oct. 10, 1923, K. Togashi.

39. Thekopsora Vacciniorum Karst.

Hab. On the leaves of *Vaccinium Vitis-idaea* L. (Kokemomo). Rebun-Island :—Momoiwa, II, Oct. 12, 1923, K. Togashi.

40. Uredinopsis filicina Magn.

Hab. On the leaves of *Dryopteris Phegopteris* (L.) C. Chr. (Miyama-warabi). Rebun-Island :—Uinnai, II (a, b), III, Aug. 10, 1922, K. Togashi.

Pucciniaceae.

41. Miyagia Anaphalidis Miyabe.

Hab. On the leaves of *Anaphalis margaritacea* Benth. et Hook. (Yama-hahako). Rishiri-Island :—Oniwaki, O, I, Aug, 4, 1922, K. Togashi ; Mt. Rishiri, O, I, Aug. 5, 1922, K. Togashi. Rebun-Island :—II, III, Aug. 24, 1907, M. Miura ; Momoiwa, O, I, Aug. 9, 1922, K. Togashi.

42. Phragmidium Rosae-rugosae Kasai.

Hab. On the leaves of *Rosa rugosa* Thunb. (Hama-nasu). Rishiri-Island :—I, II, Sept. 8, 1899, T. Kawakami ; II, III, Aug. 15, 1907, M. Miura ; Kutsugata, III, Oct. 8, 1923, K. Togashi. Rebun-Island :—III, Aug. 24, 1907, M. Miura ; Ekokinai, I, Aug. 11, 1922, K. Togashi.

43. Phragmidium Rubi-Idaei (DC.) Karst.

Hab. On the leaves of *Rubus melanolasium* Focke var. *discolor* Kom. (Yezo-ichigo). Rishiri-Island :—Oshidomari, III, Oct. 10, 1923, K. Togashi. Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. Togashi.

44. Pileolaria Toxicodendri (Berk. et Ray.) Arth.

Hab. On the leaves of *Rhus orientalis* C. K. Schm. (Tsuta-urushi). Rishiri-Island :—Otatomari, III, Aug. 7, 1922, K. Togashi. Rebun-Island :—Kabuka, III, Aug. 9, 1922, K. Togashi.

45. Puccinia Absinthii DC.

Hab. On the leaves of *Artemisia desertorum* Spreng. (Hama-otoko-yomogi). Rebun-Island :—Momoiwa, III, Oct. 12, 1923, K. Togashi.

On the leaves of *Artemisia japonica* Thunb. (Otoko-yomogi). Rebun-Island :—Momoiwa, III, Oct. 12, 1923, K. Togashi.

On the leaves of *Artemisia laciniata* Willd. var. *latifolia* Max. (Hirohakikuyomogi). Rishiri-Island :—Kutsugata, III, Oct. 8, 1923, K. Togashi. Rebun-Island :—Momoiwa, II, Aug. 9, 1922 ; III, Oct. 12, 1923, K. Togashi.

On the leaves of *Artemisia sericea* Weber. (Chishima-asagiriso). Rebun-Island :—Momoiwa, III, Oct. 12, 1923, K. Togashi.

On the leaves of *Artemisia vulgaris* L. var. *yezoana* Kudo. (Yezo-yomogi). Rishiri-Island :—Mt. Rishiri, III, Aug. 5, 1922, K. Togashi.

46. Puccinia Angelicae-edulis T. Miyake.

Hab. On the leaves of *Angelica edulis* Miyabe. (Hamaniu). Rishiri-Island :—II, III, Aug. 15, 1907, M. Miura.

On the leaves of *Angelica ursina* Max. (Yezoniu). Rishiri-Island :—II, III, July 2, 1899, T. Kawakami ; Mt. Rishiri, II, III, Aug. 11, 1899, T. Kawakami ; Oniwaki, II, III, Aug. 4, 1922, K. Togashi.

On the leaves of *Coelopleurum Gmelini* Ledep. (Hama-udo). Rishiri-Island :—Ishizaki, II, III, Aug. 7, 1922 ; Kutsugata, II, III, Oct. 8, 1923, K. Togashi.

47. Puccinia angustata Peck.

Hab. On the leaves of *Scirpus Eriophorum* Mich. (Yezo-aburagaya). Rishiri-Island :—Oniwaki, III, Oct. 11, 1923, K. Togashi.

48. Puccinia argentata (Schultz.) Wint.

Hab. On the leaves of *Impatiens Noli-tangere* L. (Ki-tsurifune).

Rishiri-Island :—Mt. Rishiri, II, III, July 27, 1899, T. KAWAKAMI ; Aug. 15, 1907, M. MIURA ; Oniwaki, II, III, Aug. 4, 1922, K. TOGASHI.

49. Puccinia Asperulae-odoratae WURTH.

Hab. On the leaves of *Asperula odorata* L. (Kurumabaso). Rishiri-Island :—Oniwaki, II, III, T. KAWAKAMI ; Oniwaki, II, Aug. 4,1922, K. TOGASHI.

50. Puccinia Baryi (BERK. et BR.) WINT.

Hab. On the leaves of *Agropyrum semicostatum* NEES. (Natsu-no-chahikigusa). Rishiri-Island :—Sempoji, II, Sept. 1, 1899, T. KAWAKAMI.

51. Puccinia Bistortae (STR.) DC.

Hab. On the leaves of *Polygonum Bistorta* L. var. *vulgare* MEISN. (Yezo-no-ibukitoranoo). Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. TOGASHI.

52. Puccinia brachysora DIET.

Hab. On the leaves of *Brachypodium japonicum* MIQ. (Yama-kamoji-gusa). Rebun-Island :—Kabuka, II, III, Oct. 12, 1923, K. TOGASHI.

53. Puccinia brevicornis ITO.

Hab. On the leaves of *Calamagrostis villosa* MUT. (Iwa-nogariyasu). Rishiri-Island :—Kutsugata, II, III, Oct. 8, 1923 ; Sempoji, II, III, Oct. 8, 1923 ; Oshidomari, II, III, Oct. 10, 1923, K. TOGASHI.

54. Puccinia calumnata SYD.

Hab. On the leaves of *Polygonum Weyrichii* Fr. SCHM. (Urajiro-itadori). Rishiri-Island :—Mt. Rishiri, II, III, Aug. 1899, T. KAWAKAMI ; II, III, Aug. 15, 1907, M. MIURA ; II, III, Aug. 9, 1922, K. TOGASHI.

55. Puccinia Caricis (SCHUM.) REB.

Hab. On the leaves of *Carex Gmelinii* FUCK. et ARN. (Nemuro-suge). Rebun-Island :—Momoiwa, III, Oct. 12, 1923, K. TOGASHI.

Remarks. *Carex Gmelinii* seems to be a new host plant to this species. The general character of this fungus corresponds exactly to *P. Caricis*.

56. Puccinia Caricis-Asteris ARTH.

Hab. On the leaves of *Aster trinervis* ROX. var. *adsutus* MAX. (Yama-shirogiku). Rebun-Island :—Momoiwa, I, Aug. 9, 1922, K. TOGASHI.

57. Puccinia Caricis-molliculae Syd.

Hab. On the leaves of *Carex mollicula* Boott. (Hime-shirasuge). Rishiri-Island :—Oniwaki, II, III, Oct. 11, 1923, K. Togashi.

58. Puccinia Chrysanthemi Roze.

Hab. On the leaves of *Chrysanthemum indicum* L. (Hama-kangiku), (cultivated). Rishiri-Island :—Oniwaki, III, Oct. 10, 1923, K. Togashi.

59. Puccinia Epigejos Ito.

Hab. On the leaves of *Calamagrostis Epigejos* Roth. var. *densiflora* Led. (Hoso-yamaawa). Rishiri-Island :—Kutsugata, III, Oct. 8, 1923, K. Togashi.

60. Puccinia erythropus Diet.

Hab. On the leaves of *Miscanthus sinensis* Anders. (Susuki). Rishiri-Island :—Sempoji, III, Oct. 8, 1923, K. Togashi.

61. Puccinia Eulaliae Barcl.

Hab. On the leaves of *Miscanthus sinensis* Anders. (Susuki). Rishiri-Island :—III, Sept. 2, 1899, T. Kawakami : III, Aug. 20, 1907, M. Miura ; Sempoji, III, Oct. 8, 1923, K. Togashi. Rebun-Island :—Uinnai, II, III, Aug. 10, 1922, K. Togashi.

62. Puccinia ferruginosa Syd.

Hab. On the leaves of *Artemisia desertorum* Spreng. (Hamaotokoyomogi). Rishiri-Island :—III, Aug. 20, 1907, M. Miura. Rebun-Island :—III, Aug. 24, 1907, M. Miura.

63. Puccinia Festucae Plowr.

Hab. On the leaves of *Lonicera coerulea* L. var. *villosa* Torr. et Gray. (Kuromi-no-uguisukagura). Rishiri-Island :—Mt. Rishiri, I, Aug. 3, 1896, W. H Rose ; I, Aug. 1, 1899, T. Kawakami.

64. Puccinia Haleniae Arth. et Halw.

Hab. On the leaves of *Halenia sibirica* Borkh. (Hanaikari). Rebun-Island :—Uinnai, III, Aug. 10, 1922, K. Togashi.

65. Puccinia Hemerocallidis Thüm.

Hab. On the leaves of *Hemerocallis Middendorfii* Trautv. et Mey. (Yezo-

kwanzo). Rishiri-Island :—III, Aug. 20, 1907, M. MIURA ; Oshidomari, II, III, Oct. 10, 1923, K. TOGASHI. Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. TOGASHI.

66. Puccinia Ishikawai ITO.

Hab. On the leaves of *Calamagrostis Epigejos* ROTH. var. *densiflora* LINDEL. (Hoso-yamaawa). Rishiri-Island :—II, III, Aug. 15, 1907, M. MIURA.

67. Puccinia lacticicola MIURA.

Hab. On the leaves of *Lactuca Raddeana* MAX. (Yama-nigana). Rishiri-Island :—Otatomari, II, III, Aug. 7, 1922, K. TOGASHI.

68. Puccinia Ligulariae MIYABE et MIYAKE sp. nov.

(Pl. V, fig. 2)

Spots yellowish brown, 3—10 mm. in diameter.

Spermogonia amphigenous, small, scattered, yellowish, 100–120μ in diameter.

Teleutosori amphigenous, often hypophyllous, small, scattered, pustuliform, long covered by the epidermis, and when ruptured surrounded by the remains, dark brown ; teleutospores variable in shape, ellipsoidal, ovate, oblong, subclavate, fusiform, broad-fusiform, mostly rounded at both ends, sometimes somewhat attenuated, slightly or not constricted at the septum, apex not thickened, smooth, lateral wall uniformly thickened, thinner than septum (3 μ thick), chestnut brown, 33–65 × 18—32μ, germ-pore of the upper cell at apex and that of the lower just below the septum, with hyaline papilla (2–3μ) thick, pedicels hyaline, very short, deciduous, 6–10μ. Mesospores oblong, 30—40 × 18—20μ.

Hab. On the leaves of *Cacalia auriculata* DC. var. *kamtschatica* MAX. (Mimi-komori). Rebun-Island :—Momoiwa, III, Aug. 9, 1922, K. TOGASHI.

On the leaves of *Ligularia sibirica* CASS. (O-takarako). Isl. Todomoshiri, Saghalien :—Dainan-dake, O, III, July 26, 1906, T. MIYAKE ; Shimizu-dani, III, July 23, 1906, T. MIYAKE ; Nakaodomari, III, July 23, 1906, T. MIYAKE.

Remarks. The present fungus has a very close resemblance to *Puccinia expansa* LINK., but its sori are long covered by the epidermis and pustuliform, while that of the latter are early naked and powdery. From *P. Tranzschelii* DIET. in TRANZSCHEL and SEREBRIANIKOW's Mycotheca Rossica Fasc. V, No. 207, the fungus in question is easily distinguished from it by the form and the persistent, long pedicel of the teleutospore, and also macroscopically. Again it differs from *P. Cacaliae* KUSANO and *P. uralensis* TRANZSCH. by the thin apex and shorter form of its teleutospores.

In 1908, M. Miura (35) first described this species in his graduation thesis,[1] basing on the specimens of a *Puccinia* on *Ligularia sibirica* Cass., which were collected by T. Miyake at Todomoshiri and Nakaodomari in Saghalien in 1906. By comparing the fungus on our host plant with his type specimens, I could not find any difference between them.

69. Puccinia Majanthemi Diet.

Hab. On the leaves of *Majanthemum bifolium* F. W. Schm. var. *kamtschaticum* Trautv. et Mey. (Maizuruso). Rishiri-Island :—III, Aug. 15, 1907, M. Miura. Rebun-Island :—Momoiwa, III, Aug. 9, 1922, K. Togashi.

70. Puccinia Menthae Pers.

Hab. On the leaves of *Mentha sachalinensis* Kudo. (Yezo-hakka). Rebun-Island :—Ekokinai, II, Aug. 11, 1922, K. Togashi.

71. Puccinia Nepetae sp. nov.

(Pl. V, fig. 1)

Teleutosori hypophyllous, on discolored spots, small, scattered or confluent, gregarious in roundish or circular groups, 1/2–2 mm. across, early naked, ruptured epidermis inconspicuous, compact, chocolate brown; teleutospores oblong, clavate, generally constricted at the septum, apex conically attenuated, rarely roundish, greatly thickened (8–12μ), base rounded or attenuated, smooth, brown, $40-72 \times 12-18\mu$, immature spores yellowish; pedicels persistent, yellowish, often deeper in color at lower and upper parts, broad, sometimes swollen, up to 100 μ long, 4–10μ wide.

Hab. On the leaves of *Nepeta subsessilis* Max. (Yezo-misogawaso). Rebun-Island :—Kabuka, III, Aug. 9, 1922; III, Oct. 12, 1923, K. Togashi. Prov. Kushiro :—Atoeka, III, July 26, 1894, K. Miyabe. Prov. Ishikari :—Mt. Sapporo-dake, III, Sept. 5, 1921, K. Togashi.

Remarks. The present fungus is easily distinguishable from any species of *Puccinia* on *Labiatae* which have been described up to the present time, by its longer form as well as long, broad and colored pedicels.

72. Puccinia Nishidana P. Henn.

Hab. On the leaves of *Circium kamtschaticum* Ledeb. var. *Grayanum* Max. (Maruba-no-hireazami). Rishiri-Island :—Oniwaki, II, III, Aug. 4, 1922, K. Togashi. Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. Togashi.

(1) This graduation thesis has not been published.

73. Puccinia Phragmitis (Schm.) Körn.

Hab. On the leaves of *Phragmites communis* Trin. (Yoshi).
Rishiri-Island :—III, Aug. 20, 1907, M. Miura. Rebun-Island :—III, Aug. 11, 1922, K. Togashi.

74. Puccinia Picridis Hazsl.

Hab. On the leaves of *Picris japonica* Thunb. (Kozorina).
Rishiri-Island :—II, Aug. 1907, M. Miura. Rebun-Island :—II, Aug. 1907, M. Miura ; Kabuka, II, Aug. 9, 1922, K. Togashi.

75. Puccinia Poarum Niesls.

Hab. On the leaves of *Poa annua* L. (Suzume-no-katabira).
Rishiri-Island :—Oshidomari, II, July 21, 1899, T. Kawakami.

76. Puccinia Polemonii Diet. et Holw.

(Pl. V, fig. 3)

Hab. On the leaves of *Polemonium coeruleum* L. var. *laxiflorum* Miyabe et Kudo. (Karafuto-hanashinobu).
Rebun-Island :—Kabuka, III, Aug. 9, 1922, K. Togashi.

Remarks. The present fungus is a species new to Japan and *Polemonium coeruleum* var. *laxiflora* is a new host plant to this species. The general character of our fungus is as follows :—

Teleutosori amphigenous, scattered, roundish, small, 1/2–1 1/2 mm. in diameter, early naked, ruptured epidermis not conspicuous, compact, pulvinate, brownish ; teleutospores oblong, constricted at the septum, rounded at both ends, apex thickened (3–6μ), yellowish or yellowish-brown, smooth, 32–45 × 12–16μ ; pedicels colorless, fragile, short.

77. Puccinia Polygoni-amphibii Pers.

Hab. On the leaves of *Polygonum sachalinense* Fr. Schm. (O-itadori).
Rishiri-Island :—Oniwaki, II, III, Sept. 1, 1899, T. Kawakami ; II, III, Aug. 4, 1922, K. Togashi ; Mt. Rishiri, II, III, Aug. 15, 1907, M. Miura.
Rebun-Island :—Kabuka, II, III, Aug. 9, 1922, K. Togashi.

78. Puccinia Ribis DC.

Hab. On the leaves of *Ribes latifolium* Jacq. (Yezo-suguri).
Rishiri-Island :—III, Aug. 15, 1907, M. Miura.

79. Puccinia Rubiae-tataricae Syd.

Hab. On the leaves of *Rubia yezoensis* (Miq.) Miyabe et Miyake. (O-akane). Rebun-Island :—Kabuka, II, Aug. 9, 1922, K. Togashi.

80. Puccinia sessilis Schneid.

Hab. On the leaves of *Phalaris arundinacea* L. (Kusa-yoshi). Rebun-Island :—Tomochi, II, III, Aug. 10, 1922, K. Togashi.

81. Puccinia silvatica Schröt.

Hab. On the leaves of *Carex Middendorfii* Fr. Schm. (Kuro-suge). Rishiri-Island :—Sempoji, II, III, Oct. 8, 1923, K. Togashi.

82. Puccinia subcircinata Ell. et Schm.

Hab. On the leaves of *Senecio palmatus* Pall. (Hangonso). Rishiri-Island :—Oniwaki, I, III, Aug. 4. 122, R. Togashi. Rebun-Island :—Uinnai, I, III. Aug. 10, 1922, K. Togashi. Saghalien :—Naioro, I, III, Sept. 1906, T. Miyake ; Garuki, I, III, Sept. 1906, T. Miyake. Kurile Islands :—Etorofu, I, Sept. 1898, T. Kawakami. Hokkaido :—Tsuishikari, near Sapporo, I, III, Aug. 1902, T. Miyake ; Bie, near Asahikawa, I, III, Aug. 1903, T. Miyake.

Remarks. So far as can be ascertained by the writer, the report that the present fungus occurs in our country has not been published and *Senecio palmatus* is a new addition to the list of the host plants of this species. The general character of our fungus is as follows :—

Aecidia hypophyllous, often amphigenous, 2–10 forming a group, rarely occurring singly, small, cupulate, yellowish ; peridium whitish, recurved, lacerate : peridial cells polygonal or rhomboidal, verrucose ; aecidiospores globoid, polygonal or ellipsoidal, wall colorless, contents yellowish, echinulate, $14-22\times12-18\mu$; teleutosori amphigenous, often petiolicolous, gregarious, sometimes arising around the aecidia or independently, minute, subimmersed with an opening, naked, pulvinate, ruptured epidermis rather conspicuous, brownish ; teleutospores variable in shape, broadly ellipsoidal, oblong, fusiform, usually rounded at both ends, apex slightly thickened, little or not constricted at the septum, smooth, chestnut-brown, $25-36\times16-22\mu$; pedicels hyaline, deciduous, rarely 35μ long.

83. Puccinia vesculosa Schlecht.

Hab. On the leaves of *Anemone narcissiflora* L. var. *sachalinensis* Miyabe et Miyake. (Yezo-no-hakusanichige). Rishiri-Island :—Mt. Rishiri, III, Aug. 1, Aug. 11, Aug. 21, 1899, T. Kawakami.

84. Puccinia Violae (Schm.) DC.

Hab. On the leaves of *Viola grypoceras* A. Gr. (Tachitsubo-sumire). Rishiri-Island :—Mt. Rishiri, II, III, Aug. 5, 1922, K. Togashi. Rebun-Island :—Momoiwa, II, III, Aug. 9, 1922, K. Togashi.

85. Puccinia Zopfii Wint.

Hab. On the leaves of *Caltha palustris* L. var. *typica* Regel. (Yezo-riukinkwa). Rishiri-Island :—Mt. Rishiri, III, July 27, 1899, T. Kawakami. Rebun-Island :—III, Aug. 24, 1907, M. Miura; Tomochi, III, Aug. 10, 1922, K. Togashi.

86. Rostrupia Elymi (West.) Laberh.

Hab. On the leaves of *Elymus dahuricus* Turc. (Hama-mugi). Rishiri-Island :—II, III, Aug. 20, 1907, M. Miura. Rebun-Island :—Tomochi, II, III, Aug. 10, 1922, K. Togashi.

On the leaves of *Elymus mollis* Trin. (Tenkigusa). Rishiri-Island :—Oshidomari, III, July, 21, 1899, T. Kawakami; Kutsugata, II, III, Sept. 2, 1899, T. Kawakami; III, Aug. 20, 1907, M. Miura. Rebun-Island :—II, III, Aug. 23, 1894, K. Miyabe; Momoiwa, II, III, Aug. 9, 1922, K. Togashi; II, III, Aug. 10, 1922, K. Togashi.

87. Triphragmium clavellosum Berk.

Hab. On the leaves of *Aralia chinensis* L. f. *asiatica* Kom. (Taranoki). Rishiri-Island :—Mt. Rishiri, III, July 21, 1899, T. Kawakami; III, Aug. 5, 1922, K. Togashi.

88. Triphragmium Ulmariae (Schum.) Lk.

Hab. On the leaves of *Filipendula kamtschatica* Max. (Oni-shimotsukeso). Rishiri-Island :—Oshidomari, III, Oct. 10, 1923, K. Togashi.

89. Uromyces Fabae (Pers.) De Bary.

Hab. On the leaves and stems of *Vicia japonica* A. Gray f. b. *sylvatica* Kom. (Hiroha-kusafuji).
Rishiri-Island :—Oshidomari, III, Oct. 10, 1923, K. Togashi.

90. Uromyces Geranii (DC.) Orth. et Wartm.

Hab. On the leaves and stems of *Geranium erianthum* DC. (Chishima-furo). Rebun-Island :—Momoiwa, III, Aug. 9, 1922; Oct. 12, 1923, K. Togashi.

91. Uromyces japonicus Berk. et Curt.

Hab. On the leaves of *Allium Victorialis* L. (Gyoja-ninniku).
Rishiri-Island :—Mt. Rishiri, III, Aug. 13, 1899, T. Kawakami; III, Aug. 1907, M. Miura.

92. Uromyces Rudbeckiae Arth. et Holw.

Hab. On the leaves of *Solidago Virga-aurea* L. (Aki-no-kirinso).

Rebun-Island :—III, Aug. 1897, T. Nishida ; Uinnai, III, Aug. 10, 1922, K. Togashi.

93. Uromyces Polygoni (Pers.) Kuck.

Hab. On the leaves of *Polygonum aviculare* L. (Michi-yanagi). Rishiri-Island :—Oshidomari, II, July 21, 1899, T. Kawakami ; II, Aug. 20, 1907, M. Miura ; Oniwaki, II, Aug. 7, 1922, K. Togashi. Rebun-Island :—Uinnai, II, Aug. 10, 1922, K. Togashi.

94. Uromyces Solidaginis (Sommerf.) Niessl.

Hab. On the leaves of *Solidago Virga-aurea* L. (Aki-no-kirinso). Rishiri-Island :—III, Aug. 1, 1899, T. Kawakami ; III, Aug. 15, 1907, M. Miura ; Mt. Rishiri, III, Aug. 5, 1922, K. Togashi.

95. Xenodocus carbonarium Schlecht.

Hab. On the leaves of *Sanguisorba tenuifolia* Fisch. var. *alta* Tr. et Mey. (Shiro-waremoko). Rishiri-Island :—III, July, 1899, T. Kawakami. Rebun-Island :—Kabuka, I, III, Aug. 9, 1922, K. Togashi.

Coleosporiaceae.

96. Coleosporium Cacaliae Otth.

Hab. On the leaves of *Cacalia auriculata* DC. var. *kamtschatica* Max. (Mimi-komori). Rebun-Island :—Uinnai, III, Aug. 10, 1922, K. Togashi.

On the leaves of *Cacalia farfaraefolia* S. et Z. var. *farfaraefolia* Max. (Miyama-komoriso). Rishiri-Island :—II, III, Aug. 1907, M. Miura.

On the leaves of *Cacalia hastata* L. var. *glabra* Ledeb. (Yobusumaso). Rebun-Island :—II, III, Aug. 1907, M. Miura.

97. Coleosporium Campanulae (Pers.) Lev.

Hab. On the leaves of *Adenophora Thunbergiana* Kudo. (Tsuriganeninjin). Rishiri-Island :—Mt. Rishiri, III, Aug. 1899, T. Kawakami ; Oshidomari, III, Aug. 7, 1922, K. Togashi.

98. Coleosporium Cimicifugatum Thüm.

Hab. On the leaves of *Cimicifuga foetida* L. var. *intermedia* Regel. (Sarashina-shoma). Rishiri-Island :—II, III, Sept. 2, 1899, T. Kawakami. Rebun-Island :—II, III, Aug. 24, 1907, M. Miura; Uinnai, II, III, Aug. 10, 1922, K. Togashi.

99. Coleosporium Ligulariae Thüm.

Hab. On the leaves of *Ligularia calthaefolia* Max. (Takarako). Rishiri-

Island :—Oshidomari, II, III, Oct. 10, 1923, K. Togashi. Rebun-Island :—Momoiwa, II, Aug. 9, 1922, K. Togashi.

Remarks. This fungus is a new addition to the fungus flora of Japan and *Ligularia calthaefolia* is a new host plant to the present fungus. The general character of our fungus is as follows :—

Uredosori hypophyllous, scattered or somewhat gregarious, about 1/2—2 cm. across, small, roundish, 1/2—2/3 mm. in diameter, early naked, bright orange-yellow or pale-yellow, surrounded by the ruptured epidermis ; uredospores elliptical globoid or obovate-globoid, 20—32 × 16—26 μ, epispore hyaline, densely verrucose, 1 1/2—3 μ thick ; teleutosori hypophyllous, scattered or aggregated, often surrounding the uredosori, sometimes confluent, up to 2 cm. across, roundish, 1/2—2 mm. in diameter, brownish or orange ; teleutospores orange-yellow, cylindrical clavate, 64—96 × 16—22 μ, rounded at both ends or attenuated below, apex very thickened, 20—40 μ, hyaline.

100. Coleosporium Phellodendri Kom.

Hab. On the leaves of *Phellodendron amurense* Rupr. var. *sachalinense* Fr. Schm. (Hiroha-no-kihada). Rishiri-Island :—Oniwaki, II, III, Aug. 5, 1922, K. Togashi.

101. Coleosporium Senecionis Fr.

Hab. On the leaves of *Senecio palmatus* Pall. (Hangonso). Rebun-Island :—Uinnai, II, III, Aug. 10, 1922, K. Togashi.

Uredinales Imperfecti.

102. Aecidium Kusanoi Diet.

Hab. On the leaves of *Cimicifuga foetida* L. var. *intermedia* Reg. (Sarashina-shoma). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

103. Aecidium Mori (Barcl.) Syd. et Butl.

Hab. On the leaves of *Morus bombycis* Koiz. (Kuwa). Rishiri-Island :—Oniwaki, Aug. 7, 1922, K. Togasai.

104. Aecidium Plantaginis Ces.

Hab. On the leaves of *Plantago kamtschatica* Link. (Yezo-obako). Rebun-Island :—Momoiwa, Aug, 9, 1922 ; Uinnai, Aug. 9, 1922, K. Togashi.

Remarks. As far as the writer is aware, *Plantago kamtschatica* is a new addition to the list of the host plants of this fungus. *Accidium* on *Plantago kamtschatica*, however, occurs commonly in Hokkaido, and there are no differences between this fungus and *Aecidium Plantaginis* on *Plantago major*,

which is very widely distributed in our country, in the measurements and other characters.

In 1907, W. Tranzschel (65) proved that *Aecidium Plantaginis* on *Plantago lanceolata* is the aecidial stage of *Puccinia Cynodontis* by inoculation experiments. In the same year, Fr. Bubák (6) reported the similar results, but he failed to prove the relationship of *Aecidium* on *Plantago major*, *P. media*, *P. Cynops* and *P. Psyllum* with *Puccinia Cynodontis*.

No account concerning the occurrence of *Cynodon* in Hokkaido, except only one case of the collection by U. Faurie[1] in Hakodate has been noticed and *P. Cynodontis* has not been found in Hokkaido. We may safely state that there is no genetic relation of *Aecidium Plantaginis* on *Plantago kamtschatica* to *Puccinia Cynodontis*.

FUNGI IMPERFECTI.

Sphaerioidaceae.

105. Cicinnobolus Cesatii De Bary.

Hab. On *Erysiphe Cichoracearum* DC. on the leaves of *Artemisia vulgaris* L. var. *yezoana* Kudo. (Yezo-yomogi). Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi.

106. Cytospora chrysosperma (Pers.) Pr.

Hab. On the branches of *Populus nigra* L. var. *italica* Duroi. (Itariya-yamanarashi), (cultivated). Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi.

107. Darluca Filum (Biv.) Cast.

Hab. On *Uromyces Polygoni* Fckl. on the leaves of *Polygonum aviculare* L. (Michi-yanagi). Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

108. Phleospora Hiratsukae sp. nov.

(Pl. V, fig. 6)

Spots irregular, often confluent, dark brown ; pycnidia epiphyllous, innate, widely opened, wall imperfectly developed, 80—100 μ in diameter, 100—120 μ in height ; conidia cylindrical, rounded at both ends, curved, guttulate, 3—6-septate, hyaline, 40—68 × 3—4 μ.

Hab. On the leaves and stipules of *Rosa rugosa* Thunb. (Hamanasu). Rebun-Island :—Ekokinai, Aug. 10, 1922, N. Hiratsuka and K. Togashi.

(1) This specimen is preserved in the herbarium of the College of Agriculture, the Hokkaido Imperial University.

109. Phyllosticta cruenta (Fr.) Kichx.

Hab. On the leaves of *Polygonatum officinale* All. var. *Maximowiczii* Max. (O-amadokoro). Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi.

110. Phyllosticta Lysimachiae Allescher.

Hab. On the leaves of *Lysimachia vulgaris* L. (Kusa-redama). Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi.

111. Phyllosticta plantaginella Sacc.

Hab. On the leaves of *Plantago major* L. var. *asiatica* Decne. (Obako). Rebun-Island :—Ekokinai, Aug. 11, 1922, K. Togashi.

112. Phyllosticta Platanoidis Sacc.

Hab. On the leaves of *Acer pictum* Thunb. var. *Mono* Pax. (Itaya-kaede). Rishiri-Island :—Oniwaki, Oct. 11, 1923, K. Togashi. Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi. Prov. Ishikari :—Maruyama, near Sapporo, Oct. 23, 1920, K. Togashi.

On the leaves of *Acer Miyabei* Maxim. (Kurobi-itaya). Prov. Ishikari :—Maruyama, near Sapporo, Oct. 23, 1920, K. Togashi.

Remarks. This species is new to Japan and *Acer pictum* var. *Mono* and *Acer Miyabei* are new additions to the list of the host-plants of the present fungus. The general character of our fungus is as follows :—

Spots irregularly angular, limited by the veins, brownish, 1/2—2 1/2 mm. across, often coalescent ; pycnidia hypophyllous immersed, only the ostiole erumpent, minute, roundish, black, 60—100 μ in diameter ; conidia very small, rod-shaped, straight, often more or less curved on one side, rounded at both ends, hyaline, 3.5—4.5 × 0.7—1 μ.

113. Septoria Artemisiae-japonicae sp. nov.

(Pl. V, fig. 4)

Spots elliptical or irregular, 3—7 mm. long, 2—4 mm. wide, dark brown ; pycnidia amphigenous, innate, small, black, subglobose, 132—258μ in diameter, 148—200 μ in height ; conidia cylindrical or attenuated at one end, curved, 3—7-septate, guttulate, hyaline, 64—96 × 4—5 μ.

Hab. On the leaves of *Artemisia japonica* Thunb. (Otoko-yomogi). Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi. Prov. Ishikari :—Oshoro, near Otaru, Oct. 10, 1922, K. Togashi.

Remarks. The present fungus is easily distinguished from *Septoria Artemisiae* Pass. or *S. fusca* Peck. by the size of conidia.

114. Septoria Cannabis (Lasch.) Sacc.

Hab. On the leaves of *Cannabis sativa* L. (Asa). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

115. Septoria Convolvuli Desm.

Hab. On the leaves of *Calystegia sepium* R. Br. f. *major* Mak. (O-hirugao). Rishiri-Island :—Kutsugata, Oct. 8, 1923, K. Togashi.

116. Septoria Haleniae sp. nov.

Spots roundish or irregular, often confluent, sometimes covering a greater part of the surface of the leaf, dry, pale brown, fuscous-margined ; pycnidia epiphyllous, scattered, minute, immersed, black, globose, 40—58 μ in diameter ; conidia filiform, straight or curved, continuous or with one septum, hyaline, 27—40 × 1—1.5 μ.

Hab. On the leaves of *Halenia sibirica* Borkh. (Hana-ikari). Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

Remarks. As far as the writer is aware, there is no account concerning the occurrence of any *Septoria* on *Halenia*. We may safely treat the fungus in question as a new species.

117. Septoria polygonina Thüm.

Hab. On the leaves of *Polygonum Blumei* Meisn. (Inu-tade). Rishiri-Island :—Oniwaki, Aug, 4, 1922, K. Togashi.

118. Septoria Ribis Desm.

Hab. On the leaves of *Ribes Grossularia* L. (Maru-suguri). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

119. Septoria Sonchina Thüm.

Hab. On the leaves of *Sonchus oleraceus* L. (Nogeshi). Rishiri-Island:—Island :—Oniwaki, Oct. 11, 1923, K. Togashi.

120. Septoria Stellariae Rob. et Desm.

Hab. On the leaves of *Stellaria media* Vill. (Hakobe). Rishiri-Island:—Sempoji, Oct. 8, 1923, K. Togashi.

Remarks. The present species is a new addition to the mycological flora of Japan.

121. Septoria Violae Westd.

Hab. On the leaves of *Viola grypoceras* A. Gr. (Tachi-tsubosumire). Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

On the leaves of *Viola Patrini* DC. var. *chinensis* Ging. (Sumire). Rebun-Island :—Uinnai, Aug. 19, 1922, K. Togashi.

122. Stagonospopa Pini-pumilae sp. nov.

(Pl. V, fig. 5)

Pycnidia amphigenous, scattered, covered by the epidermis, blackish or subcarbonaceous, 160—200 μ in diameter, 140—240 μ in height; conidia cylindrico-fusiform, generally curved, hyaline, 3-septate, 36—48 × 3—4 μ.

Hab. On the leaves of *Pinus pumila* Regel. (Hai-matsu). Rishiri-Island :—Mt. Rishiri, Aug. 5, 1922, K. Togashi.

Remarks. The present fungus is easily distinguished from *Stagonospora Pini* Grove by the more than twice longer conidia and the other characters.

Mucediaceae.

123. Bostrychonema alpestre Cesati.

(Pl. V, fig. 9)

Hab. On the leaves of *Polygonum Bistorta* L. var. *vulgare* Meisn. (Yezo-no-ibukitoranoo). Rishiri-Island :—Mt. Rishiri, Aug. 5, 1922, K. Togashi.

Remarks. The present fungus is a new addition to the mycological flora of Japan and *Polygonum Bistorta* var. *vulgare* is a new host plant to this species. The general character of our fungus is as follows :—

Spots dark brown, limited by the veins; conidiophores hypophyllous, tufty, erect, simple, spirally twisted, septated, hyaline, 68—152 × 4—6 μ; conidia acrogenous, ellipsoidal, later bicellulate, more or less constricted at the septum, echinulate, hyaline, 20—28 × 14—16 μ.

124. Cercosporella cana Sacc.

Hab. On the leaves of *Erigeron Thunbergii* A. Gr. var. *glabratum* A. Gr. (Yezo-no-azumagiku). Rishiri-Island :—Ishizaki, Aug. 7, 1922, K. Togashi.

125. Cercosporella Chaerophylli Aderhold.

(Pl. V, fig. 10)

Hab. On the leaves of *Anthriscus sylvestris* Hoffm. (Shaku). Rebun-Island :—Kabuka, Aug. 10, 1922, K. Togashi.

Remarks. The present species is a new addition to the mycological flora of Japan and *Anthriscus sylvestris* (=*Chaerophyllum sylvestre* Linn.) is a new host plant to it. This fungus was first described by Aderhold in 1902 and his description is somewhat incomplete, but as we find many common characters

between them, we shall treat the fungus in question under the present name. The general character of our fungus is as follows ;—

Spots irregular, limited by the veins, rarely confluent, 2—6 mm. in length, 1/2—2 mm. in width, brownish to grey ; conidiophores amphigenous, tufty, somewhat flexuous, hyaline or light colored, short, 16—20 × 4—6 μ ; conidia narrow cylindrico-clavate or cylindrico-linear, guttulate, 1—4- septate, hyaline, 48—84μ long, up to 96 μ, 4—6 wide.

126. Cercosporella Petasitidis Shirai et Sono

Hab. On the leaves of *Petasites japonicus* Miq. (Fuki). Rishiri-Island :— Oshidomari, Oct. 10, 1923, K. Togashi.

127. Ramularia decipiens Ell. et Ev.

Hab. On the leaves of *Rumex obtusifolius* L. (Yezo-no-gishigishi). Rishiri-Island :—Sempoji, Oct. 8, 1923, K. Togashi.

Remarks. The present fungus is a new addition to the mycological flora of Japan.

128. Ramularia Epilobii-palustris All.

Hab. On the leaves of *Epilobium glandulosum* Lehm. (Karafuto-aka-bana). Rishiri-Island :—Ishizaki, Aug. 7, 1922, K. Togashi.

Remarks. The present fungus is a new addition to the fungus flora of Japan and *Epilobium glandulosum* is a new host plant to this species. The general character of our fungus is as follows :—

Spots ochraceous, limited by the veins, often coalescent ; conidiophores hypophyllous, rarely amphigenous, erect, septated, hyaline, 36—48 × 3—4 μ ; conidia cylindrical, straight, 1—2- septate, hyaline, 24—40 × 3—4 μ.

129. Ramularia Geranii (Westend.) Lind.

Hab. On the leaves of *Geranium sibiricum* L. (Ichige-furo). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 9, 1922, K. Togashi.

Remarks. The present fungus is a new species to Japan and *Geranium sibiricum* is a new addition to the list of the host plants of this species. The general character of our fungus is as follows :—

Spots roundish, often limited by the veins, coalescent, ochraceous ; conidiophores hypophyllous, subsimple, mostly not septated, hyaline or subhyaline, 36—60 × 3—4 μ ; conidia cylindrical, somewhat acute at both ends, continuous or with one septum, straight or slightly curved, hyaline or subhyaline, 24—4 × 4—6 μ.

130. Ramularia Stachydis (Pass.) Mass.

Hab. On the leaves of *Stachys japonica* Miq. f. *villosa* Kudo. (Inu-goma).

Remarks. The present species is new to Japan and *Stachys japonica* f. *villosa* is a new addition to the list of the host plants of this species. The general character of our fungus is as follows :—

Spots irregular, often coalescent, 2—8 mm. across, brownish ; conidiophores hypophyllous, rarely amphigenous, flocculent and powdery, white, short, not branched, unseptate, 1—2-denticulate towards the apex, $18-36 \times 4-5\ \mu$; conidia cylindrical, roundish or more or less acuminate at both ends, continuous or 1—2- septate, hyaline, $16-26 \times 4-5\ \mu$.

131. Ramularia Taraxaci Karst.

Hab. On the leaves of *Taraxacum officinale* Web. var. *lividum* Koch. (Yezo-tampopo). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi.

Dematiaceae.

132. Cercospora Araliae P. Henn.

Hab. On the leaves of *Aralia chinensis* L. var. *canescens* Matsum. (Medara). Rebun-Island :—Kabuka, Oct. 12, 1923, K. Togashi.

133. Cercospora Chenopodii Fr.

Hab. On the leaves of *Chenopodium album* L. (Akaza). Rishiri-Island:—Oniwaki, Oct. 11, 1923, K. Togashi. Rebun-Island ;—Ekokinai, Aug. 11, 1922, K. Togashi.

134. Cercospora graminicola Tracy et Earle.

(Pl. V, fig. 8)

Hab. On the leaves of *Beckmannia erucaeformis* Host. (Mino-gome). Rebun-Island :—Funadomari, Aug. 11, 1922, K. Togashi.

Remarks. This species is a new addition to the mycological flora of Japan and *Beckmannia erucaeformis* is a new host plant to the present fungus. In 1895, S. M. Tracy and F. S. Earle (61) first described the fungus found on *Phleum pratense* L. under the name above mentioned. By comparing the characters of our fungus with the original description of *Cercospora graminicola*, we can not recognize the clear and decided differences between them, except our fungus has the linear spots on the living leaf while the other none. The general character of our fungus is as follows :—

Spots linear, often confluent, up to 40 mm. in length, 1/2—2 mm. in width, brownish, becoming greyish in center ; conidiophores amphigenous,

erect, densely fasciculate, somewhat flexuous toward the tip, fuscous, 1—2-septate, 70—120 × 4—6 μ; conidia clavate, continuous when young, finally 1—3-septate, light olivaceous, 38—56 × 8—9 μ.

135. Cercospora Gotoana sp. nov.

Spots irregular, small, reddish brown; conidiophores hypophyllous, erect, densely fasciculate, somewhat flexuous, simple, 1—3-septate, fuscous, 84—168 × 4—6 μ; conidia cylindrico-clavate, curved, 1—3-septate, light olivaceous, 52—84 × 4—6 μ.

Hab. On the leaves of *Sorbaria sorbifolia* A. Br. var. *glabra* Max. (Yezo-no-hozaki-nanakamado). Rishiri-Island:—Mt. Rishiri, Aug. 5, 1922, K. Togashi.

Remarks. The fungus in question is closely related to *Cercospora Kruegeriana* Bres., but it can easily be distinguished from the latter by the fact that the conidia and conidiophores of our fungus are twice longer than those of the latter. It also differs from *Cercospora Ariae* Fuck. by reddish brown spots as well as by the longer size of conidia.

In memory of the late Mr. Takeo Goto, assistant of our Botanical Institute, who has ascended Mt. Rishiri with us, I wish to name the present fungus after him.

136. Cercospora Miurae Syd.

Hab. On the leaves of *Cynanchum caudatum* Max. (Ikema). Rishiri-Island:—Oniwaki, Oct. 11, 1923, K. Togashi. Rebun-Island:—Kabuka, Oct. 12, 1923, K. Togashi.

137. Cercospora Polygonati-Maximowiczii sp. nov.

Spots large, irregular, often limited by the veins, greyish olive, later blackish; conidiophores hypophyllous, tufty, flexuous, septate, not branched, fuscous, 48—72 × 6—7 μ; conidia long-obclavate, curved, rarely straight, light olivaceous, 1—4-septate, 40—58 × 6—8 μ.

Hab. On the leaves of *Polygonatum officinale* All. var. *Maximowiczii* Max. (O-amadokoro). Rishiri-Island:—Oniwaki, Aug. 4, 1922, K. Togashi. Prov. Ishikari:—Mt. Teine, near Sapporo, July 4, 1922; Bannosawa, near Otaru, July 21, 1923, K. Togashi.

Remarks. The present species has a very close resemblance to *Cercospora Victorialis* Thüm. but its conidiophores are not branched and its conidia longer. The fungus in question differs from *Cercospora Polygonati* Rostr. by the shorter and broader forms of the conidia, as well as by the nature of spots.

138. Napicladium arundinaceum (Corda) Sacc.

Hab. On the leaves of *Phragmites communis* Trin. (Yoshi). Rishiri-Island :—Otatomari, Aug. 7, 1922, K. Togashi. Rebun-Island :—Uinnai, Aug. 10, 1922, K. Togashi.

Stilbaceae.

139. Isariopsis albo-rosella (Desm.) Sacc.

Hab. On the leaves of *Stellaria aquatica* Scop. (Ushi-hakobe). Rishiri-Island :—Oniwaki, Aug. 4, 1922, K. Togashi. Rebun-Island :—Kabuka, Aug. 9, 1922, K. Togashi.

On the leaves of *Stellaria media* Vill. (Hakobe). Rebun-Island :—Kabuka, Aug. 10, 1922, K. Togashi.

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Carex Gmelinii Fuck. et Arn.	*Puccinia Caricis* (Schum.) Reb.
Carex Middendorfii Fr. Schm.	*Puccinia silvatica* Schröt.
Carex mollicula Booth.	*Puccnia Caricis-molliculae* Syd.
Carex sachalinensis Kük.	*Balansia vorax* (Berk. et Curt.) Atk.?
Cerastium triviale Link. var. *glandulosum* Koch.	*Melampsorella Caryophyllacearum* Schr t.
Chenopodium album L.	*Peronospora Chenopodii* Casp.
	Cercospora Chenopodii Fr.
Chrysanthemum indicum L.	*Puccinia Chrysanthemi* E. Roze.
Cimicifuga foetida L. var. *intermedia* Reg.	*Aecidium Kusanoi* Diet.
	Coleosporium Cimicifugatum Thüm.
Circium kamtschaticum Ledeb. var. *Grayanum* Max.	*Puccinia Nishidana* P. Henn.
Coelopleurum Gmelini Ledeb.	*Puccinia Angelicae-edulis* T. Miyake.
Cryptotaenia japonica Hasskarl.	*Plasmopara nivea* (Ung.) Schroet.
Cynanchum caudatum Max.	*Cercospora Miurae* Syd.
Dryopteris Phegopteris (L.) C. Chr.	*Uredinopsis filicina* Mag.
Elymus dahuricus Turcz.	*Phyllachora graminis* (Pers.) Fuck.
	Rostrupia Elymi (West.) Lagerh.
Elymus mollis Trin.	*Phyllachora graminis* (Pers.) Fuck.
	Rostrupia Elymi (West.) Lagerh.
Epilobium angustifolium L.	*Pucciniastrum Epilobii* (Pers.) Otth.
Epilobium glandulosum Lehm.	*Ramularia Epilobii-palustris* All.
Erigeron Thunbergii A. Gr. var. *glabratum* A. Gr.	*Cercosparella cana* Sacc.
Filipendula kamtschatica Max.	*Triphragmium Ulmariae* (Schum.) Lk.
Galeopsis Tetrahit L.	*Erysiphe Galeopsidis* DC.
Geranium erianthum DC.	*Erysiphe Polygoni* DC.
	Uromyces Geranii (DC.) Otth. et Wartm.
Geranium sibiricum L.	*Erysiphe Polygoni* DC.
	Ramularia Geranii (Westend.) Lend.
Halenia sibirica Borkh.	*Puccinia Haleniae* Arth. et Holw.
	Septoria Haleniae Togashi.
Hemerocallis Middendorfii Trautv. et Mey.	*Puccinia Hemerocallidis* Thüm.
Hypericum crassifolium Nakai.	*Melampsora Kusanoi* Diet.
Hypericum erectum Thunb. f. *Fauriei* (Keller) Miyabe et Miyake.	*Mesopsora Hypericorum* (DC.) Diet.
Hypericum yezoense Max.	*Mesopsora Hypericorum* (DC.) Diet.
Impatiens Noli-tangere L.	*Sphaerotheca fuliginea* (Schlecht.) Sawada.
	Puccinia argentata (Schulz.) Wint.
Lactuca Raddeana Max.	*Bremia Lactucae* Regel.
	Puccinia lacticicola Miura.
Ligularia calthaefolia Max.	*Coleosporium Ligulariae* Thüm.
Ligusticum scoticum L.	*Plasmopara nivea* (Ung.) Schroet.
Lonicera coerulea L. var. *villosa* Torr. et Gray.	*Puccinia Festucae* Plowr.
Lysimachia vulgaris L.	*Phyllosticta Lysimachiae* Allescher.

Majanthemum bifolium F. W. Schm. var. *kamtschaticum* Trautv. et Mey.	*Puccinia Majanthemi* Diet.
Mentha sachalinensis Kudo.	*Puccinia Menthae* Pers.
Miscanthus sinensis Anders.	*Puccinia erythropus* Diet.
	Puccinia Eulaliae Barcl.
Morus bombycis Koidz.	*Phyllactinia Corylea* (Pers.) Karst.
	Aecidium Mori (Barcl.) Syd. et Butl.
Nepeta subsessilis Max.	*Puccinia Nepetae* Togashi.
Oxyria digyna Hill.	*Ustilago vinosa* (Berk.) Tul.
Phellodendron amurense Rupr. var. *sachalinense* Fr. Schm.	*Coleosporium Phellodendri* Kom.
Peracarpa circaeoides Fee.	*Pseudopeziza Peracarpae* Miyabe. et Togashi.
Petasites japonicus Miq.	*Cercosporella Petasitidis* Shirai et Sono.
Phalaris arundinacea L.	*Puccinia sessilis* Schneid.
Phragmites communis Trin.	*Puccinia Phragmitis* (Schm.) Körn.
	Napicladium arundinaceum (Corda.) Sacc.
Picea Glehni Mast.	*Chrysomyxa Rhododendri* De Bary.
Picris japonica Thunb.	*Bremia Lactucae* Rgl.
	Erysiphe Polygoni DC.
	Puccinia Picridis Hazsl.
Pinus pumila Regei	*Stagonospora Pini-pumilae* Togashi.
Plantago kamtschatica Link.	*Erysiphe Cichoracearum* DC.
	Aecidium Plantaginis Ces.
Plantago major L. var. *asiatica* Decne.	*Peronospora alta* Fuck.
	Erysiphe Cichoracearum DC.
	Phyllosticta plantaginella Sacc.
Poa acroleuca Steud.	*Phyllachora Poae* (Fuck.) Sacc.?
Poa annua L.	*Puccinia Poarum* Niesls.
Polemonium coeruleum L. var. *laxiflorum* Miyabe et Kudo.	*Puccinia Polemonii* Diet. et Holw.
Polygonatum officinale All. var. *Maximowiczii* Max.	*Phyllosticta cruenta* (Fr.) Kichx.
	Cercospora Polygonati-Maximowiczii Togashi.
Polygonum aviculare L.	*Uromyces Polygoni* (Pers.) Fuck.
	Darluca Filum (Biv.) Cast.
Polygonum Bistorta L. var. *vulgare* Meisn.	*Puccinia Bistortae* (Str.) DC.
	Bostrychonema alpestre Cesati.
Polygonum Blumei Meisn.	*Sphaerotheca Hydropiperis* (Schm.) De Bary.
	Septoria polygonina Thüm.
Polygonum nodosum Pers.	*Ustilago utriculosa* (Nees.) Unger.
Polygonum sachalinense Fr. Schm.	*Puccinia Polygoni-amphibii* Pers.
Polygonum Weyrichii Fr. Schm.	*Puccinia calumnata* Syd.
Populus nigra L. var. *italica* Dur.	*Melampsora Larici-populina* Kleb.
	Cytospora chrysosperma (Pers.) Fr.
Rhododendron chrysanthum Pall.	*Chrysomyxa expansa* Diet.
Rhus orientalis C. K. Schm.	*Pileolaria Toxicodendri* (Berk. et Rav.) Ar.
Ribes Grossularia L.	*Septoria Ribis* Desm.
Ribes latifolium Jacz.	*Puccinia Ribis* DC.
Ribes sachalinensis Nakai.	*Cronartium ribicola* Fisch.

Rosa rugosa THUNB.	*Phragmidium Rosae-rugosae* KASAI.
	Phleospora Hiratsukae TOGASHI.
Rubia yezoensis (MIQ.) MIYABE et MIYAKE	*Puccinia Rubiae-tataricae* SYD.
Rubus melanolasium FOCKE var. *discolor* KOM.	*Phragmidium Rubi-Idaei* (DC.) KARST.
Rumex obtusifolius L.	*Ramularia decipiens* ELL. et EV.
Salix sachalinensis FR. SCHM.	*Rhytisma salicinum* (FERS.) FR.
	Valsa ambiens (FERS.) FR.
	Melampsora Larici-opaca MIYABE et MATSUMOTO.
Sanguisorba tenuifolia FISCH. var. *alta* TR. et MEY.	*Xenodocus carbonarium* SCHLECHT.
Sasa kurilensis MAK. et SHIB.	*Coccodiella Arundinariae* HARA.
	Phyllachora Shiraiana SYD.
Scirpus Eriophorum MICH.	*Puccinia angustata* FECK.
Senecio palmatum PALL.	*Coleosporium Senecionis* FR.
	Puccinia subcircinata ELL. et EV.
Skimmia japonica THUNB.	*Beloniella Skimmiae* MIYABE et TOGASHI.
Solanum tuberosum L.	*Phytophthora infestans* (MONT.) DE BARY.
Solidago Virga-aurea L.	*Uromyces Rudbeckiae* ARTH. et HOLW.
	Uromyces Solidaginis (SOMMF.) NIESSL.
Sonchus oleraceus L.	*Septoria Sonchina* THÜM.
Sorbaria sorbifolia A. BR. var. *glabra* MAX.	*Cercospora Gotoana* TOGASHI.
Stachys japonica MIQ. f. *villosa* KUDO.	*Ramularia Stachydis* (PASS.) MASS.
Stellaria media VILL.	*Septoria Stellariae* ROB. et DESM.
	Isariopsis albo-rosella (DESM.) SACC.
Stellaria yezoensis MAX	*Melampsorella Caryophyllacearum* SCHRÖT.
Taraxacum officinale WEB. var. *lividum* KOCH.	*Ramularia Taraxaci* KARST.
Thalictrum minus L. var. *elatum* LECOY.	*Erysiphe Polygoni* DC.
Vaccinium Vitis-idaea L.	*Thekopsora Vacciniorum* KARST.
Vicia japonica A. GRAY. f. b. *sylvatica* KOM.	*Uromyces Fabae* (PERS.) DE BARY.
Viola grypoceras A. GR.	*Puccinia Violae* (SCHM.) DC.
	Septoria Violae WESTD.
Viola Patrini DC. var. *chinensis* GING.	*Septoria Violae* WESTD.

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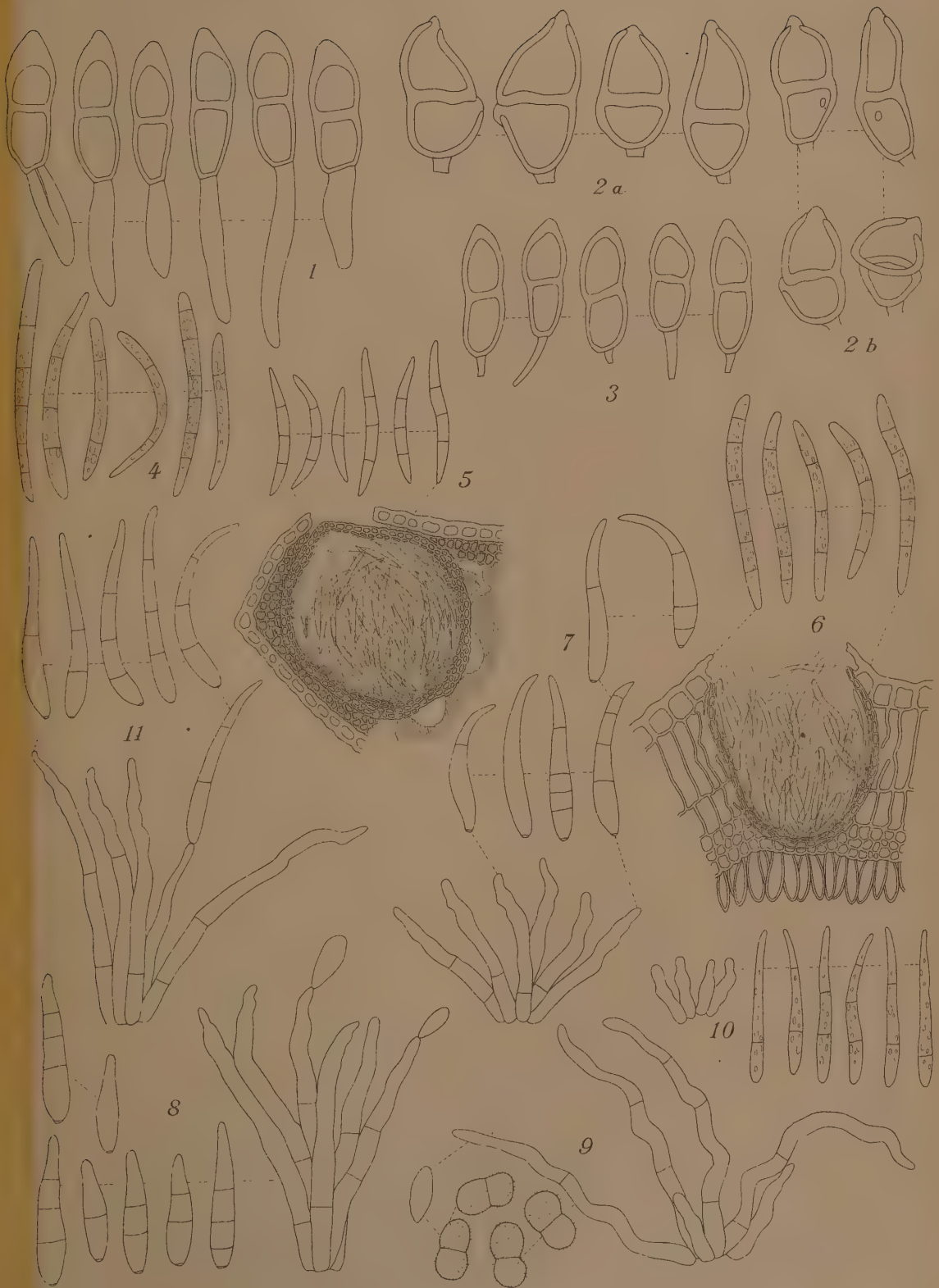
Explanation of Figures.

Plate V.

All figures are drawn with the aid of a camera lucida.

1) *Puccinia Nepetae* TOGASHI sp. nov.
2) a. *Puccinia Ligulariae* MIYABE et MIYAKE sp. nov. on *Cacalia auriculata* DC. var. *kamtschatica* MAX.
   b. Ditto on *Ligularia sibirica* CASS. (After Mr. M. MIURA).
3) *Puccinia Polemonii* DIET. et HOLW. on *Polemonium coeruleum* L. var. *racemosum* MIYABE et KUDO.
4) *Septoria Artemisiae-japonicae* TOGSAHI sp. nov.
5) *Stagonospora Pini-pumilae* TOGASHI sp. nov.
6) *Phleospora Hiratsukae* TOGASHI sp. nov.
7) *Cercospora Polygonati-Maximowiczii* TOGASHI sp. nov.
8) *Cercospora graminicola* TRACY et EARLE on *Beckmannia erucaeformis* HOST.
9) *Bostrychonema alpestre* CESATI on *Polygonum Bistorta* L. var. *vulgare* MEISN.
10) *Cercosporella Chaerophylli* ADERH. on *Anthriscus sylvestris* HOFFM.
11) *Cercospora Gotoana* TOGASHI sp. nov.



K. Togashi del.

On the Flax Anthracnose and its Causal Fungus, Colletotrichum Lini (WESTERDIJK) TOCHINAI.

By **Makoto HIURA**, *Nogakushi*.

(With Plate VI and 3 Text-figures.)

(Communication from the Botanical Institute, Hokkaidô Imperial University.
Received March 29, 1924.)

Contents.

Numerous papers concerning the flax anthracnose have been published by several authors, but it seems to me, there are still left unsolved certain questions on the life-history of its causal fungus. From the spring of 1921, I have been studying this anthracnose, and have obtained some results which seem worthy to be reported.

I wish to express here my sincere thanks to Prof. K. MIYABE, under whose kind directions these investigations have been made, and also to Prof. S.

Ito, for his valuable suggestions. The author is also indebted to Prof. T. Hemmi, Dr. N. Hiratsuka and Assist. Prof. Y. Tochinai for their kind help.

Historical Review.

Pethybridge and Lafferty's paper (12) which was published in 1918, is apparently the first scientific contribution on this disease. The authors described not only the causal fungus as a new species, but also made a careful investigation of the diseased seeds. Of all their valuable results, it was an important discovery that the causal organism lodges in the epidermis of the seed-coat as a hybernating mycelium aud it is a chief annual source of the disease.

Previously, three other investigators, Bolley (1) in America, Schoevers(1) and Westerdijk(2) in Holland had undertaken the study of this anthracnose. Bolley published his papers in 1910 and 1912. He called the disease "Flax Canker" and gave a name *Colletotrichum Lini* to the causal organism. But Bolley's reports were of popular nature, giving no description of the fungus. In 1915, Schoevers published an account of a flax anthracnose in Holland. According to Pethybridge and Lafferty's quotation (12), Schoevers called attention to sunken patches on the young stem, and ascribed its causal organism to a species of *Colletotrichum*. But no specific name of the fungus was given. Westerdijk published her papers in 1915 and 1918. According to Schilling's quotation (17), she gave a name *Gloeosporium Lini* to her fungus.

In 1920, Pethybridge and Lafferty (13) published the first report of a serial publication under the topic, "Investigations on Flax Diseases." In this paper, seven flax diseases were described, and the first one of them was "Seedling Blight" caused by *Colletotrichum linicolum*. Though it was only a popular statement of their previous paper, there are two noticeable things to be mentioned here. One is that in this report they wrote the mycelium of the fungus hybernates "within the cells forming the *outer layers* of the seed-coat" (p. 329), while in the previous report, "within the cells of the *outer epidermis* of the seed-coat." The other is that in spite of their efforts they found no example of pod infection (p. 330).

In 1921, Pethybridge, Lafferty and Rhynehart (14) published the second report of their series. As for the "Seedling Blight" disease, only short notes were given. This time, they stated that several examples of the spotted seed-bolls caused by the *Colletotrichum* fungus were discovered. But they gave no details of their experiments.

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(1) (2) Original papers not seen.

In 1922 E. Schilling (17) published a paper concerning the flax anthracnose in Germany. He was apparently the first investigator in his country. The results obtained from his detailed investigations generally coincide with those of Pethybridge and Lafferty's, although he also investigated some other sides of the question, such as the varietal and specific susceptibility of flax.

In the same year Pethybridge, Lafferty and Rhynehart (15) published the third report of their investigations. However, only a brief note was given to the *Colletotrichum* disease.

In Japan, the flax anthracnose was first found in 1918 in the experimental plots of the Hokkaido Agricultural Experiment Station in Sapporo by K. Katsufuji, formerly assistant plant pathologist of the Station. In May of the same year, T. Hemmi (8) isolated the fungus in pure culture and identified it with *Colletotrichum linicolum* P. et L. In December, Y. Tochinai (19) published some results of his investigations on the prevention of the flax diseases. He performed seed disinfection using various kinds of antiseptics. Later, T. Hemmi (9) who studied the Japanese *Gloeosporium*, also dealt with the causal fungus of the flax anthracnose, and published many papers on the disease.

In 1921, K. Sawada (16) described *Colletotrichum linicolum* as causing a serious damage to the flax plant in Formosa. He observed that there are different grades of susceptibility to the disease in the cultivated races of the flax plant. Moreover, he stated that the fungus attacks the floral parts.

Identification and Nomenclature.

A few years ago, the causal fungus of our flax anthracnose was identified with *Colletotrichum linicolum* P. et L. by T. Hemmi (8) and Y. Tochinai (19) in our Botanical Laboratory. In 1921, K. Sawada (16) in Formosa also identified his fungus with *Colletotrichum linicolum*.

I have easily succeeded in isolating the fungus in pure culture from various affected parts of the flax plant, and have ascertained that it is quite one and the same with *Colletotrichum linicolum* P. et L. from the morphological and physiological characteristics, and also the pathogenicity of the fungus, as well as the symptoms of the disease.

One thing to be added here is about the identity of the causal fungus of Bolley's flax canker in America. It is very regretful that, as has been already stated, no one has hitherto been able to identify his fungus with Bolley's because he gave no description of the fungus.

Last year, an interesting unpublished manuscript concerning the flax diseases written in 1908 by T. F. Manns was sent from the author to Prof.

Y. Tochinai at his request. Fortunately, I was able to read the transcript of that paper by Prof. Tochinai's kindness. T. F. Manns gives the detailed description of the causal fungus of Bolley's flax canker in that paper. According to his description, the causal fungus of the American flax canker is without any doubt identical with that of ours.

As for the nomenclature of the fungus in question, different names have been proposed. Schilling accepted (17, p. 91) Westerdijk's *Gloeosporium Lini* in preference to *Colletotrichum linicolum* P. et L., because of the priority as well as the inconstancy of the formation of setæ.

On the other hand, Pethybridge and Lafferty (12) named their fungus *Colletotrichum linicolum*, while Tochinai (20) has expressed an opinion to accept Westerdijk's name, placing it, however, in the genus *Colletotrichum*.

In the last ten years, as a result of artificial cultures of the fungus, certain investigators have an opinion that the genus *Colletotrichum* must be included in the genus *Gloeosporium*, in spite of the fact that the latter is newer than the former, on account of the unstability of setæ. Krüger (10) in Germany and Hemmi (9) in Japan found examples of certain *Colletotrichum*, whose setæ were unstable. On the other side, Gardner (5) in America, studying *Colletotrichum lagenarium* on cucurbits, found setæ present in all the strains studied during the course of his work, and he stated that it seemed quite logical to retain the name *Colletotrichum* for his fungus until the perfect stage is discovered.

From this point of view, there are two opinions ; one is that being often unstable setæ should not be adopted as a generic character, and the name *Gloeosporium* in a broad sense is rather to be accepted, while the other is that the name *Colletotrichum* is to be adopted for such fungi which form setæ in nature whether they be stable or unstable. The latter opinion is generally accepted by mycologists at present, but this problem should be more fully investigated. For the fungus in question, I wish to retain it under *Colletotrichum* calling it *Colletotrichum Lini* (Westerdijk) Tochinai.

Some Remarks on the Causal Organism.

The full description of the causal fungus has been already given by the previous authors, and therefore, I have described here only the studies of other particulars concerning the causal fungus such as spore germination, spore and setæ formation, nucleus and appressorium.

1. Spore Germination.

Spores from a month old culture were used. Small drops of spore suspension in nutrient solutions were placed on a slide in a moist chamber and observed under the microscope. Generally, the spores lying in the middle of the drop usually do not germinate, while those lying near the border mostly do. This difference of behavior is probably due to difference in oxygen supply (s. Pl. VI, fig. 4).

The mode of germination varies much, depending upon the shape of the spore and the character of the medium. (Pl. VI, fig. 5). In somewhat curved spores, a germ-tube first appears from each end of the spore, and both germ-tubes always come out on the concave side, taking the same parallel or slightly diverging directions. In such spores, a septum is usually formed in the middle of the spore either before or after the spore germination, and later, one or two germ-tubes come out often from near the septum also on the concave side. In short cylindrical spores, a germ-tube projects from one end and the direction of the germ-tube is determined by the surrounding conditions. Such spores usually do not form septa.

I have observed a remarkable phenomenon in Konjak powder decoction and corn meal decoction. In these two media, the germ-tubes are produced from every portion of the surface. When spores are lying near by, their germ-tubes easily anastomose with each other. The connection occurs when a germ-tube comes near another germ-tube or spore. Afterwards, these connected spores usually form septa.

The septation of the spore varies somewhat in different media. In Konjak powder decoction and corn meal decoction, most spores form septa, while in apricot decoction, about a half of the spores do not form septa.

As was already discovered by the other investigators of certain fungi, I have also proved the presence of the mucilaginous sheath around the mycelium, especially at the portion near the tip. The gelatinous or mucilaginous substance is easily demonstrated by staining with weak gentian violet for thirty seconds and mounting in water. The mucilage is not found in the earliest stage of germination.

In fixed and stained preparations, the mucilaginous material no longer appears as a continuous substance, but is reduced to a number of fine granular threads which connect the hyphæ and spores. As Blackman and Welsford (3) inferred, the threads are, in all probability, due mainly to the action of the dehydrating agents, such as alcohol. The threads appear to be connecting not only the germ-tubes, but also the spores and appressoria to the substratum.

2. Spore Formation.

When the mycelium is growing in a nutrient solution, first a small bud-like body is seen to be produced at the tip of a fertile hypha. The bud-like body gradually grows and becomes a conidium. The new conidia do not readily separate from the tips of the conidiophores which are unbranched and compactly aggregated.

As far as I have observed, the mode of spore formation does not change with the different outer conditions, contrary to the mode of spore germination.

3. The Nucleus Problem.

The conidium is uninucleate as a rule. In a fresh living spore, the nucleus appears as a rather large hyaline body near the middle of the spore, generally situated close to the wall. It may be easily mistaken for a vacuole or an oil drop. But, its true nature has been proved by nuclear stains. Oil drops which are readily stained red by Sudan III, are, in general, highly refractive and have a distinct circular outline, while the nucleus appears to be only a clear hyaline body with indistinct outline. Such a nuclear, hyaline body is usually not recognized in old spores or in poorly developed ones.

For the nuclear staining, the best result has been obtained by the following method: the fungus cultured in nutrient media on slides or in hanging drops for one or two days, is immediately fixed in Carnoy's fluid for thirty minutes and then stained by Delafield's hæmatoxylin; as the fungus adheres firmly to the substratum, there is a great facility for the staining work. I have often found that some large spores contain from two to four nuclei. Usually, the spores over 25μ in length have two or more nuclei. Such nuclei are, sometimes, situated in pairs, showing as if they have just been derived from a nuclear division. (S. Pl. VI, fig. 1).

In the mycelium of the fungus in question, when it was cultured in nutrient media, I have occasionally found numerous nuclei apparently arranged in pairs. Such nuclei in the mycelium are smaller in size than those in spores.

The similar observations on the nuclei within the spores were previously made by Edgerton (4) who studied the physiology and development of some anthracnoses; he recognized a clear hyaline body within the spore as a nucleus, and also occasionally found two nuclei in larger spores.

As for the nuclei within the mycelium, Blackman and Welsford (3) observed similar paired nuclei in the mycelial cells of *Botrytis cinerea*. Welsford (21) inferred that the paired condition of the nuclei might be the

response to the physiological conditions usually found in such hyphæ when high nutrition is associated with a rapid growth.

4. The Appressorium.

The formation of the appressorium is one of the most characteristic features of the fungi causing the anthracnose. When the tip of the hypha as it grows, comes in contact with the hard surface of a cover glass or epidermis of a host, it swells out and soon a septum is formed, delimiting it from the rest of the mycelium. It soon becomes a dark brown, thick-walled, irregular-shaped, chlamydospore-like body. This body is the so-called appressorium of Hasselbring and others.

As for the factors influencing the formation of appressoria, there are a number of opinions. Hasselbring (7), working with the fungus of the apple bitter-rot found that appressoria were formed only as a result of a contact stimulus in a medium poor in food supply. Gardner (5), in his studies of the anthracnose of cucurbits concluded that "with this fungus then the presence of food material does not seem to inhibit appressorium formation. The contact stimulus is apparently necessary as a rule, and a liberal oxygen supply seems to be favourable to appressorium formation."

I have found that the nature of nutrient media greatly influences the appressorium formation. In onion juice in which the fungus grows vigorously and forms abundant spores, there are found also abundant appressoria, while in apricot juice in which the spore formation is sparse and mycelial growth is exceedingly vigorous, there are always found fewer appressoria. Moreover, the shape of the appressorium seems to be much influenced by the nature of a medium. In certain media, the appressorium often develops a new hypha or reproduced itself and forms an irregular chain of appressoria. I have also observed that the appressoria are formed more readily about the margin of the drop. In short, I believe that contact stimulus, oxygen supply and nutrient material are at least the important factors influencing the formation of appressoria.

When the appressorium becomes old and is about to reproduce a new appressorium or a hyphal branch, the very portion where a new growth is going to take place, becomes light coloured and looks very much like a germ-pore under a microscope. Such a light coloured spot, from which an infection tube proceeds, is also found in the appressorium formed on the epidermis of the host. This light portion is not found in the young appressorium and it differs from the usual germ-pore. (S. Pl. VI, figs. 2–3).

5. The Formation of Setae.

The formation of setæ is not observed in slide culture or hanging drop culture, but is always produced in certain old media. In culture, it is formed as a kind of branch of the mycelium, and its length is longer and septation oftener than that formed in the host tissue.

In the host tissue, the seta arises as a hyaline, short, non septate bristle. By inoculation experiments on cotyledonary leaves I have found that a seta arises singly from a septate segment of the old mycelium piercing through the tissue. However, setæ are usually produced at the periphery of the acervulus.

In old Konjak powder decoction agar slanted in a test tube, I have found the setæ growing in clusters like those in the genus *Vermicularia*, thus showing the close connection between the genera *Colletotrichum* and *Vermicularia*. (S. Pl. VI, fig. 6).

Observations and Experiments on the Diseased Flax Plant.

It may be correctly said that these investigations begin in diseased seeds and end in diseased seeds. I have continuously endeavoured to ascertain the exact course of the life-cycle of the causal fungus. The following results are arranged in the order of my investigations.

1. Diseased Seeds.

In the spring of 1921, at the beginning of my investigations of the flax anthracnose, I obtained from the Hokkaido Agricultural Experiment Station some quantities of the flax seed of the variety "Pelnau," which had been harvested in 1920. Those seeds were so much injured that I could easily notice the diseased seeds at a glance. (S. Pl. VI, 10 a-b).

The surface of the affected seeds was commonly dull and rough, as the previous investigators had already stated. When they were hand-sectioned and examined under the microscope, abundant mycelia were observed in the mucilaginous epidermis. I took one hundred of the diseased seeds at random to make them germinate at 26°C., using sterilized Petri-dishes which had been fitted up with a piece of wet blotting paper and glass cylinders. In three days, ninety of the seeds germinated, but the rest did not. In five days, some showed whitish or blackish aerial mycelia on the surface, and I examined them with the microscope one by one. To my great surprise, the whitish mycelia were of *Fusarium Lini* Bolley forming then abundant microconidia, and the

blackish were an *Alternaria*, though some of the blackish included both *Alternaria* and *Fusarium*. At first, I ascribed these unexpected fungi to some accidental sources, but by careful repetition of a similar experiment, I was able to prove that both fungi had actually been lodged in the seed-coat.

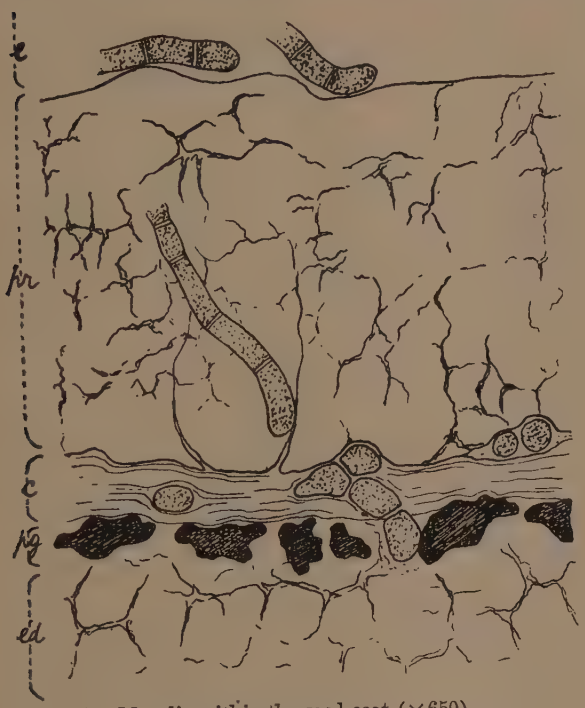

Fig. 1. Mycelia within the seed-coat (×650).
e, Mucilaginous epidermis.
pr, Hypertrophied parenchymatous layer.
c, Compressed layer.
pg, Pigment layer.
ed, Endosperm.

For, during these experiments, I frequently observed that some of the affected seeds which had mycelia in their seed-coats, produced either pure *Fusarium* or pure *Alternaria*.

How and when these fungi lodged in the seed-coat is not yet understood. In spite of my repeated experiments, I could obtain no *Colletotrichum* fungus. Later, I found that the variety "Pelnau" is comparatively resistant to the anthracnose.

Afterwards, I received some quantities of the flax seeds of the variety "Argentine" from the Teikoku Flax Manufacturing Company in Sapporo. These also included many diseased seeds which showed similar appearances as in the case of the variety "Pelnau," and the microscopical examination of their sections proved that the mycelium lodges in the cells of the mucilaginous epidermis of the seed-coat (Text-fig. 1). Out of one hundred of these diseased seeds sown in Petri-dishes, ninety one germinated and the rest did not. After three days, the *Colletotrichum* fungus which was no doubt identical with the one described by the previous authors was found on the surface of most seeds. But an *Alternaria* fungus was also discovered on some of them. This time, no *Fusarium* was found. I repeated these experiments and obtained similar results. Thus, in diseased seeds of flax there may lodge in the epidermal cells the hyphæ of either one or two species of fungi belonging to *Colletotrichum*,

Alternaria or *Fusarium*. Macroscopically, no differences could be recognized among these diseased seeds, but their causal fungi were distinguishable only by germination tests.

In the fall of the same year, I frequently visited the Hokkaido Agricultural Experiment Station in order to observe the preparation of the flax seed and there I found unexpectedly a number of severely attacked seeds of the varieties, "London" and "Burbank." Thus, I become aware of the fact that the commercial flax seed is unfit for the investigation of diseased seed, because the severely affected ones have mostly been eliminated. In the threshing process, the worst diseased seeds are all winnowed out because of their lightness.

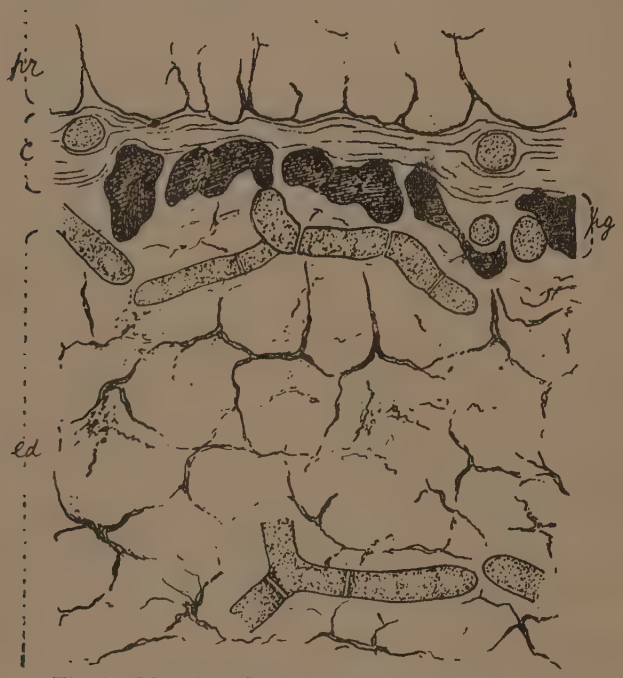

Fig. 2. Mycelia within the endosperm (×650).
pr, Hypertrophied parenchymatous layer.
c, Compressed layer.
pg, Pigment layer.
ed, Endosperm.

The severely affected seeds were irregularly shrunken, much smaller in size and covered with pinkish or sometimes grayish aerial mycelia on the surface. When the hand-sections of these seeds were examined under the microscope, the mucilaginous epidermis was almost broken off and abundant mycelia were present on the surface of the seed-coat.

For the purpose of the microtome sections, some of the severely attacked seeds were first boiled in distilled water in a test tube to be softened and swollen. Then, after cooling, they were fixed in Carnoy's fluid, dehydrated by absolute alcohol and embedded in paraffin as usual. Sections were cut 8μ thick, and stained by Pianeze's method. Trials proved that the differenciation was obscure in thinner sections.

By careful examination with the microscope, I discovered that the septate

hyphæ lodged not only in the layers of the seed-coat, but also in the albumen and the cotyledon (Text-figs. 2 and 3). Originally, the seed-coat of the flax seed is composed of five layers, namely the first is a mucilaginous epidermis, the second parenchymatous, the third sclerenchymatous, the fourth compressed, and the fifth a pigment layer. However, in these severely attacked seeds, the epidermis was broken off, the second layer markedly hypertrophied and the third, sometimes absent. Moreover, the arrangement and form of cells were greatly disturbed in every layer.

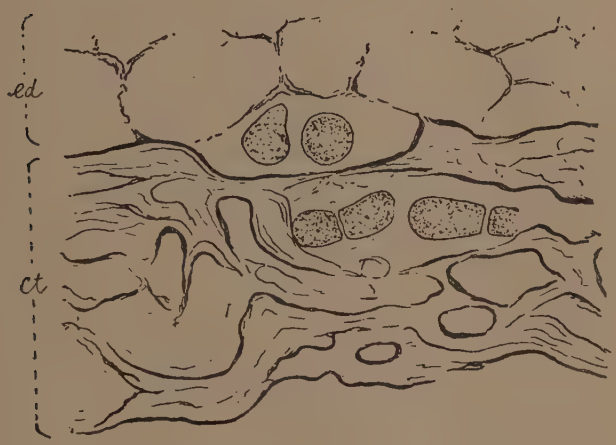

Fig. 3. Mycelia within the cotyledon (×650).
ed, Endosperm.
ct, Cotyledon.

In November of 1922, I obtained some dried mature flax plants bearing the capsules, from the store-house of our College Farm. They were of the variety "London." When I carefully examined the capsules, to my great surprise, the majority of them were attacked by the *Colletotrichum* fungus. All the severely affected seeds from these diseased capsules produced without any exception the *Colletotrichum* in a moist chamber. The appearance of such seeds was generally similar to that of the variety, "India" and "Burbank."

As a rule, the severely affected seeds did not germinate and when placed in a moist chamber, they were soon covered with the acervuli bearing pink masses of spores and a number of black setæ. This is a remarkable characteristic of this fungus.

2. Injuries to Seedlings.

As has been already pointed out, the hybernating mycelium within the diseased seed begins to grow in a favourable moist condition and forms abundant spores and setæ. This is the reason why the hybernating mycelium within the seed-coat causes the seedling trouble. When the diseased seed-coat is carried out of the ground on the tip of the cotyledonary leaves, the cotyledons are first attacked, while if the diseased seed-coat is cast off on the

ground, the hypocotyl is generally attacked at the ground level. The former case is far more common than the latter.

When the seedling is an inch or two in height, the discoloured sunken areas, which are often spherical or semi-spherical in shape, appear at the margin of the upper surface of the cotyledonary leaf (Pl. VI, fig. 7). These areas, increasing in size, gradually become pale brown in colour and show somewhat concentric rings on the surface, presenting the rhythmic growth of the invading mycelium. It is commonly observed that a cotyledonary leaf is attacked in two or more places. The lesions sometimes coalesce with one another and gradually involve the whole surface. At times, one lesion increases in size until a half of the surface is involved. Drying and shrinkage are the final symptoms of the affected cotyledons, which usually remain long attached to the stem, if hypocotyl is sound. In many cases, however, the hypocotyl is attacked about the same time as the cotyledonary leaf, and the whole seedling becoming dried up, shrinks and falls in death.

The hypocotyl is generally attacked at the ground level, though any portion further up may be invaded. On the colourless portion at the ground level the lesions are rusty, but on the green portion the colouration is not different from that of the lesions on the cotyledonary leaves.

The affected portion usually shows a conspicuous dent which, at first sight, may be mistaken for damage resulting from an insect attack. I have often found that the hypocotyl remains standing for a long time although injured in several portions. By inoculation experiments, however, I observed frequently that the portion above a certain point of the hypocotyl suddenly withered and hung down, indicating a heavy attack. The similar symptom has been often found, too, on the very susceptible varieties such as "London" or "India."

It is noticeable that the anthracnose fungus does not usually attack the roots of the seedling, while the wilt fungus chiefly attacks them. In nature, I have met no cases of the *Colletotrichum* attacking directly the root of flax, although I occasionally found that the lesion formed at the ground level had extended into the soil. The roots of the seedlings placed on a moist blotting paper in a Petri-dish were, however, easily attacked by the fungus when some affected seedlings were lying near by.

When the sections of the dead cotyledonary leaves are examined under the microscope, acervuli bearing abundant spores and setæ are always found. If the lesion is in an early stage, it takes one or two days to have those characteristic acervuli fully formed in a moist chamber culture.

3. Injuries to Mature Leaves and Stems.

The symptoms of affected mature leaves are very remarkable on the susceptible varieties of the flax plant (Pl. VI, fig. 9). The upper surface of the leaves is spotted by many circular brown areas. At a certain distance, the lesions appear conspicuously as black spots.

At first, a discoloured area appears on the surface of the leaf as in the case of the cotyledonary leaf, and gradually becomes brown, increasing in size. The final stage of the symptom is drying and shrinkage. A mature leaf may be attacked in many places, and two or more spots often unite with one another.

If the spot is carefully observed, the central portion is found to be grayish brown and the margin dark brown, showing somewhat concentric rings. The spot usually varies from 1 mm to 4 mm in diameter, and is spherical, elliptical or sometimes irregular. However, considerable differences in the shape and size of the spots are recognized according to the varieties.

On the mature stem, the brown spot is also formed, but is rather small, and noticeable only by a close observation. The branches are more susceptible than the main stems. When the old lesion of the affected leaf is sectioned and examined under the microscope, many acervuli bearing spores and setæ are found. In these cases, the sizes of setæ and spores are generally smaller than those on the cotyledonary leaves. I have never found in nature the acervuli on the young lesions of the mature leaves.

4. Injuries to Floral Parts and Capsules.

The fungus which has attacked the mature leaves, gradually spreads to the higher parts. Calyces, buds and capsules are equally attacked. The round lesions on calyces are similar in all respects to those on the mature leaves, except their smaller size. When buds are attacked, they become dried up and remain attached for a long time. The capsules are commonly attacked on their lower halves, especially near the point of attachment to the axes. The affected portions are usually distorted and become discoloured. But, in the majority of cases, the lesions are usually sheltered behind the calyces, and therefore, it may be difficult for untrained eyes to find the affected capsules in the field, especially when the lesions are of lighter colour as is often found in the variety "India." On the whole, however, the affected capsule is smaller in size and shows always some distortion at the lesion. When such capsules are carefully dissected, not only the diseased seeds are found, but also the mycelium of the causal fungus is recognized on the wall of the capsule cells. I have

succeeded in isolating the *Colletotrichum* fungus directly from the diseased seeds within the affected capsules.

5. Varietal Susceptibility.

The fact that different grades of susceptibility exist among the different varieties of flax has already been reported by Bolley (2), Sawada (16) and Schilling (17). Bolley briefly noted that flax seed which is resistant to the wilt does not always prove to be resistant to the canker. Sawada observed that the Indian races of flax were severely affected, while the Belgian races in the same field were only slightly affected. Schilling stated that the seeds of "Dutch White," "Dutch Blue" and the Chinese races, etc. were free from the *Colletotrichum* disease, although he succeeded to infect their seedlings with the *Colletotrichum* fungus by artificial inoculation.

During the course of my investigations, I have found, too, a great variation of susceptibility among the varieties of flax used in the present experiments. The broad leaved varieties of seed flax, "London," "India," "Burbank" and "Argentine" are very susceptible to the anthracnose, while the narrow leaved varieties of fibre flax, "Pelnau," "Belgium," Prof. Minami's "Wilt Resistant Variety," etc. are comparatively resistant. I have also noticed that some of the Dutch and Russian races are somewhat susceptible.

6. Factors controlling Spore Dissemination.

The fungus is no doubt distributed most extensively by the diseased seed. The vitality of the conidial spore is markedly decreased by drying so that when the spore is kept dry for some time it plays a very small part in the dissemination of the fungus. On the contrary, the vitality of the conidial spore is wonderfully kept longer by moisture. The lesions of the mature leaf often hardly produce spores and acervuli in the field in this part of Japan on account of the prevalence of dry climate, but in a moist chamber they soon produce acervuli bearing abundant spores and setæ. Practically, wind is the most important factor in the dissemination of the fungus. I have noticed that the mature plants in a greenhouse suffer less damage than those in the field.

7. Inoculation Experiments.

How and when the fungus invades the seed is an interesting problem. It must be actually solved by inoculation experiments.

On May 10, 1922, the first inoculation experiment was performed in a greenhouse where the temperature fluctuated from 15° to 25°C. The

susceptible variety "Argentine" was used for the experiments, and it was then about one and a half feet tall, forming already buds, flowers and young capsules on the plant.

One week old spores formed on onion decoction agar, of the *Colletotrichum* fungus, which had been originally isolated from an affected seedling, and suspended in sterilized water, were sprayed on the plant by an atomizer. Two pots were prepared, one was inoculated, the other used as a control. The pots were covered with large moist bell-jars for 48 hours after inoculation.

When the bell-jars were put aside, the petals had fallen, anthers and stigmata had been attacked and disorganized. Four days later, the characteristic spots of the anthracnose were recognized on young capsules, calyces and leaves. Attacked flowers and buds stopped their growth and dried up gradually. The young capsules were also attacked, especially near the basal portions and showed the characteristic symptoms.

When they were fixed, cut, stained and examined under the microscope, it was proved that the fungus hyphæ had reached the young seeds through the tissues of the capsule. The half matured capsules were somewhat resistant to attack, and the invasion was mostly restricted to their peripheral tissues only. The capsules showing a weaker growth had their peduncles often attacked by the fungus to more or less extent. Throughout the experiment, the control was free from the disease.

On June 1, the second inoculation experiment was performed, this time without control, and quite similar results were obtained. When the stigmata and anthers are attacked, they are usually disorganized, and the further growth of the hyphæ seems generally to be stopped. It is, then, highly probable that the infection of the diseased seed does not originate primarily from the stigmata or anthers.

At times, we can not explain the phenomena in the field by the results of the artificial experiments in the greenhouse, because the external conditions, which are very important for infection, are very different. However, the results set forth in the foregoing pages may give a clew to the right understanding on the process of seed infection.

Discussion.

The above-mentioned results obtained from my observations and experiments coincide with those of other investigators in many respects, but there are two interesting, remarkable facts which should be fully discussed here, that is, (1) the hybernating mycelium within the seed, and (2) the injury to the full-grown flax plant.

1. Hybernating Mycelium within the Seed.

On the hybernating mycelium within the flax seed, some observations were previously made by certain investigators. Bolley (2) in America made some diseased seeds germinate and found cankered embryos among them. From this experiment, although he did not record about its method in detail, he recognized that such diseased seeds are internally infected. Pethybridge and Lafferty (12) in Ireland stated, contrary to Bolley's opinion, that the mycelium of the causal fungus lodges only within the *outer epidermis* or the *outer layers* of the seed-coat and never within the endosperm nor the embryo.

Now, according to my observations and experiments, there are various grades of infection, from the slightly affected seeds which are indistinguishable at a glance from the sound ones to the severely attacked seeds. In the former, the mycelium lodges only within the outer mucilaginous epidermis of the seed-coat, but in the latter case, the mycelium lodges not only in the endosperm but also in the embryo.

As to the slightly or moderately affected seeds, Pethybridge and Lafferty's statements apparently coincide with my own observations. As it has been already pointed out, the commercial flax seed is unfit for the investigation, because the severely affected seeds are usually eliminated in the threshing process, and it may be probable that differences of opinion are due to the materials investigated. As far as I have observed, the slightly affected seeds usually germinate, but the severely affected ones never do. It seems to me that Bolley's cankered embryos of germinating seeds may be due to the secondary infection and not to the primary cankered ones.

2. Injury to the Full-grown Flax Plant.

As for the injury to the full-grown flax plant, there have been no detailed accounts. K. Sawada (16) in Formosa is the first, who noticed the injury of the mature plant in Japan. Pethybridge, Lafferty and Rhynehart (14) also reported the similar accounts. But they gave no details.

It is rather noteworthy that only few investigators have noticed the injury of the mature plant. In Hokkaido, the injury of the mature flax plant is very common. In the susceptible varieties, the symptoms on mature leaves are especially very remarkable. The diseased capsules are also commonly found.

According to my inoculation experiments, the fungus no doubt attacks all parts of the flax plant, in all stages of its development. When the fungus attacks the capsule, the mycelium gradually spreads to the seed, finally infect-

ing it. The grades of seed-invasion are usually much influenced by two important factors. One is the age of the capsule and seed, and the other, the varietal susceptibility. The younger the capsule and seed are, the more susceptible they are. The mature capsule and seed are usually not attacked by the fungus, perhaps owing to physical causes. If the pigment layer of the seed-coat is completely formed, the fungus seems no longer to be able to pierce that layer. Only in an early stage of the seed when the pigment layer of the seed-coat is not yet formed, the fungus is able to invade the endosperm as well as embryo. Of course, in such an early stage of the seed the embryo does not yet attain its full growth at the time of infection, and therefore the seed with such infected endosperm or embryo is naturally unable to germinate.

Varietal susceptibility plays also an important role in relation to seed infection. The severely attacked seeds are usually found in the susceptible varieties such as "India," "London," "Burbank" and "Argentine," while they are not found in the somewhat resistant variety such as "Pelnau." Without the consideration of these important factors, the matters concerning the exact process of seed infection and the hybernating mycelium within the seed can not be actually solved.

Conclusions.

1. The causal fungus of the flax anthracnose attacks all parts of the flax plant, leaves, stems, floral parts, capsules and seeds, in all stages of its development, from seedlings to maturity.

2. There are two types of the symptoms on the seedlings; one is "Damping off" and the other "Canker." The former is usually found in very susceptible varieties and the latter in somewhat resistant ones.

3. The symptoms on the mature plant are so remarkable in the susceptible varieties that they should be considered as an important characteristic of this disease.

4. The fungus, which attacked the capsule generally at its lower half, gradually piercing its tissues, finally infects the seeds within.

5. In the slightly affected seeds, the mycelium lodges in the mucilaginous epidermis of the seed-coat only, while in the severely affected ones, the mycelium lodges not only in all the layers of the seed-coat, but also in the endosperm or cotyledon. The former germinates as usual, but the latter never germinates.

6. When the capsule and seed have attained their growth up to a certain degree, the fungus can not attack them, perhaps owing to some physical causes.

When the pigment layer of the seed-coat is completed, the fungus can no longer attack either the endosperm or the cotyledon.

7. To solve the particulars concerning seed infection and the hybernating hyphæ within the seed, the susceptibility of the varieties and the age of the flax plant should be fully considered.

8. The fungus is chiefly disseminated by means of conidial spores in nature. Wind is the important factor of dissemination of the fungus.

In 1921, Lafferty (11) published an interesting paper concerning the "Browning," a serious flax disease in Ireland. The causal fungus of the disease was provisionally ascribed to the genus *Gloeosporium* by Pethybridge and Lafferty (12, 13), but in this paper, Lafferty named the fungus *Polyspora Lini* as a new species of a new genus. According to his statement, the disease has been found on flax grown in Ireland from seed believed to have been derived from crops grown in Japan and other countries (p. 272). In Hokkaido, however, the disease has not yet been found.

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Explanation of Plate VI.

Fig. 1. Conidia, showing nuclei (×2000).
Fig. 2. Two appressoria and the tip of a hypha, showing mucilaginous substance (×1037).
Fig. 3. Peculiar-shaped appressoria (×1037).
Fig. 4. Conidia microphotographed.
Fig. 5. Germinating conidia (×1037).
Fig. 6. Setae, showing their development (×1037).
c, a young conidium.
Fig. 7. Diseased cotyledons (3 times the natural size).
Fig. 8. Diseased mature leaves (double the natural size).
Fig. 9. A sound capsule and three diseased ones (double the natural size). *s*, sound, *d*, diseased.
Fig. 10. Sound and diseased seeds (*ca.* ×8).
a, sound ; *b*, diseased.

Fig. 7, 8 and 9 were drawn by Mr. C. Suzaki.


1
2
3
4
d
10a
10b
s
8
d
d
9
5
7
c
6